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# ATRAN3S: AN UNSTEADY TRANSONIC CODE FOR CLEAN WINGS

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## SUMMARY

This report explains the development and applications of the unsteady transonic code ATRAN3S for clean wings. Explanations of the unsteady, transonic small-disturbance aerodynamic equations that are used and their solution procedures are discussed. A detailed user's guide, along with input and output for a sample case, is given.

## INTRODUCTION

In the last decade, there have been extensive developments in computational unsteady transonic aerodynamics (ref. 1). Such developments are essential since the transonic regime plays an important role in the design of modern aircraft. For example, flight in the transonic regime provides the most efficient cruise performance because of the high lift-to-drag ratios that prevail under transonic conditions (ref. 2). However, it is at just such Mach numbers that the "dip" in the flutter curve (ref. 3) occurs. Consequently, there has been a large effort to develop computational tools with which to perform accurate flutter analyses at transonic speeds.

In the area of computational fluid dynamics (CFD), the unsteady, transonic aerodynamics are characterized by the feature of modeling the motion of shock waves over aerodynamic bodies, such as airfoils or wings. This modeling requires the solution of nonlinear partial differential equations. At the present time, the most advanced codes use the small-disturbance, transonic potential equation. These codes are being used for generic research in aeroelasticity. Currently, codes are being developed that use the more exact full-potential equation. In comparison, for steady flows, practical applications use full-potential codes, and there is extensive development of Euler codes.

The successful development of two-dimensional codes like LTRAN2 (ref. 4), which employ an alternating-direction-implicit (ADI), finite-difference scheme (ref. 1), and the availability of faster computers with more memory, make possible the

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development and use of three-dimensional, unsteady transonic aerodynamic codes. An initial step was taken by Traci et al. (ref. 5) who developed the three-dimensional steady and unsteady small-disturbance codes TDSTRN and TDUTRN, respectively. The unsteady code TDUTRN is based on the harmonic method in which an unsteady solution is linearized with respect to time, and shock waves are fixed with respect to steady-state position. Thus, it is limited to the cases with very small oscillations. Eastep and Olsen (ref. 6) applied these codes to the computation of the flutter boundaries of a rectangular wing by using an uncoupled aeroelastic method.

Next, for more accuracy, Borland and Rizzetta (ref. 7) developed a three-dimensional, unsteady, small-disturbance transonic code, XTRAN3S, based on a time-integration method. In that code, the finite-difference scheme for two-dimensional flows employed in LTRAN2 (ref. 1) was extended to three-dimensional flows over wings. The unsteady equations of motion are time-accurately integrated by an ADI scheme that allows the shock waves to move. Also, this code can perform static and dynamic aeroelastic computations by simultaneously integrating the aerodynamic and structural equations of motion. The XTRAN3S code is being used for both aerodynamic and aeroelastic applications (refs. 8-10).

The use of XTRAN3S was limited to rectangular wings and wings with low sweep angle, large taper ratio, and large aspect ratio, such as transport aircraft wings. This limitation was due to the nature of the coordinate transformation that was used. The XTRAN3S code was not applicable to fighter-type wings, which are characterized by low aspect ratio, high sweep angle, and low taper ratio. Also, the code was not portable and it lacked some important features, a Fourier analyzing capability of the unsteady data. In order to overcome these limitations, a parallel improved code, ATRAN3S was developed at Ames Research Center. This code, which has a modified coordinate transformation along with many other new features, is applicable to both transport and fighter wings. This report explains the basic algorithm used in ATRAN3S, Version 1, and gives some typical examples.

## FORMULATION OF UNSTEADY TRANSONIC-FLOW EQUATIONS

A discussion of the derivation of the three-dimensional, small-disturbance unsteady equations is given by Yoshihara (ref. 11). In accordance with reference 11, the modified small-disturbance equation for unsteady flow is written as

$$A\phi_{tt} + B\phi_{xt} = (E\phi_x + F\phi_x^2 + G\phi_y^2)_x + (\phi_y + H\phi_x\phi_y)_y + (\phi_z)_z \qquad (1)$$

where $A = M_\infty^2$; $B = 2M_\infty^2$; $E = (1 - M_\infty^2)$; $F = -(1/2)(\gamma + 1)M_\infty^2$; $G = -(1/2)(\gamma - 3)M_\infty^2$; and $H = -(\gamma - 1)M_\infty^2$. The coefficients F, G, and H are those proposed by Lomax et al. (ref. 12) when deriving the modified small-disturbance equation for steady flows.

The flow-field boundary conditions used are

$$\text{Far downstream:} \quad \phi_x + k\phi_t = 0 \tag{2a}$$

$$\text{Far upstream:} \quad \phi = 0 \tag{2b}$$

$$\text{Far above and below:} \quad \phi_z = 0 \tag{2c}$$

$$\text{Far spanwise:} \quad \phi_y = 0 \tag{2d}$$

$$\text{Wing root:} \quad \phi_y = 0 \tag{2e}$$

$$\text{Trailing vortex wake:} \quad [\phi_z] = 0 \tag{2f}$$

$$[\phi_x + k\phi_t] = 0 \tag{2g}$$

where the [ ] denotes the jump in the quantity across the vortex sheet.

The wing surface-flow tangency condition, which is satisfied at the mean chord plane, is given by

$$\phi_z = f_x + kf_t = 0 \tag{3}$$

where $f_x$ denotes airfoil surface function; and where $k = \omega c/U_\infty$ and is the reduced frequency based on the full root chord ($\omega$ is the frequency in radians per second, $c$ is a reference chord length, and $U_\infty$ is the free-stream velocity).

## Transformation for Swept-Tapered Wings

Equation (1), which is ideal for rectangular wings, can pose problems for swept tapered wings because of the dependence of its solution on leading-edge mesh spacing. Maintaining a sufficiently fine mesh spacing along the leading edge of a swept wing in a Cartesian coordinate system is inefficient because of the large number of points required. An alternative approach was developed by Ballhaus and Bailey (ref. 13). A shearing transformation was used to map a trapezoidal planform wing in the physical plane into a rectangle in the computational plane, as shown in figure 1 where

$$\xi(x,y) = (x - x_{LE})/c \; ; \qquad \eta(y) = y \; ; \qquad \zeta(z) = z \tag{4}$$

and where $c$ is the local chord.

The leading and trailing edges lie on the coordinate lines $\xi = 0$ and 1, respectively. Use of this shearing transformation permits a more efficient distribution of mesh points, and each span station ($\eta$ = const) has the same number of chordwise mesh points on the wing surface. The problem of distributing grid points properly at the leading and trailing edges of the wing has been dealt with

precisely. This shearing transformation was used in XTRAN3S (ref. 7) throughout the flow field.

The conventional shearing transformation (4) is simple and adequate for wings with small sweep and large taper ratio. However, for wings with low apsect ratio, high sweep angle, and small taper ratio, such as fighter wings, this shearing transformation is not adequate. Since the transformation (4) is a function of local chord, the upstream and downstream far-field boundaries of the region in which the flow is computed depends on the planform. Thus, near those boundaries for delta-type wings (1) the coordinate lines are highly nonorthogonal, (2) the metrics have a large discontinuity in direction near the wing-tip span station, and (3) the flow is not normal to these boundaries. Thus, large discontinuities occur in the metric $\xi_y$ along the tip span station. The metric appears as a coefficient for cross-derivatives. Also, in XTRAN3S the cross-derivatives have been differenced explicitly. These features of the shearing transformation can make the flow computations unstable, as has been illustrated for the F-5 wing (ref. 14).

In order to remove these disadvantages of the conventional shearing transformation, a modified shearing transformation was developed (ref. 14). The main requirement that any transformation should satisfy for the finite-difference method used in XTRAN3S is that it should map any given wing to a rectangular wing. This is satisfied in the modified shearing transformation by using the same conventional shearing transformation given by equation (4). However, for use away from the wing, a new scheme was devised such that the grid lines have the following properties: (1) far-field physical boundaries to the flow region are independent of the planform and always form the boundaries of a rectangular box, with the upstream and downstream surfaces normal to the free stream; (2) smaller gradients are obtained for the metric quantities, particularly near the boundaries, and smooth first and second derivatives are obtained for the metric quantities; and (3) grid lines are clustered near the leading and trailing edges as before for the shearing transformation. The details are given in reference 14.

After applying the transformation, equation (1) can be written as

$$-(A\xi_x^{-1}\phi_t + B\phi_\xi)_t + [E\xi_x\phi_\xi + F\xi_x^2\phi_\xi^2 + G(\xi_y\phi_\xi + \phi_\eta)^2 + \xi_x^{-1}\xi_y(\xi_y\phi_\xi + \phi_\eta) + H\xi_y\phi_\xi(\xi_y\phi_\xi + \phi_\eta)]_\xi + [\xi_x^{-1}(\xi_y\phi_\xi + \phi_\eta) + H\phi_\xi(\xi_y\phi_\xi + \phi_\eta)]_\eta + [\xi_x^{-1}\phi_\zeta]_\zeta = 0 \qquad (5)$$

The differencing procedure for equation (5) is an extension of the Murman-Cole type-dependent difference procedure applied to an arbitrary coordinate system (ref. 7). Type-dependent differences are used only to approximate derivatives in the streamwise direction, and all other derivatives are approximated by central differences. This method approximates the rotated differencing developed by Jameson (ref. 15). Thus the coefficient $G$ is split into two components $G_S$ and $G_N$ where $G_S = 1 - M_\infty^2$, such that equation (5) may be decomposed into streamwise and normal contributions to the spatial differencing. Equation (5) can now be written as

$$-(A\xi_x^{-1}\phi_t + B\phi_\xi)_t + [E\xi_x\phi_\xi + F\xi_x^2\phi_\xi^2 + (G_S + G_N)(\xi_y\phi_\xi + \phi_\eta)^2 + \xi_x^{-1}\xi_y(\xi_y\phi_\xi + \phi_\eta)$$
$$+ H\xi_y\phi_\xi(\xi_y\phi_\xi + \phi_\eta)]_\xi + [\xi_x^{-1}(\xi_y\phi_\xi + \phi_\eta) + H\phi_\xi(\xi_y\phi_\xi + \phi_\eta)]_\eta + [\xi_x^{-1}\phi_\zeta]_\zeta = 0 \qquad (6)$$

where

$$G = G_S + G_N \; ; \qquad G_S = 1 - M_\infty^2 \; ; \qquad G_N = (1/2)(\gamma - 2)M_\infty^2 - 1$$

Equation (6) is solved by a time-accurate ADI scheme. Details can be found in references 4 and 7.

## Viscous Corrections

Inviscid codes can provide reasonably good physical descriptions of the flow for cases in which viscous effects are not significant. Viscous effects, when significant, can cause (1) an altering of shock strength and location because of shock and boundary-layer interaction; (2) camber modifications because of differences in the boundary-layer displacement on the upper and lower airfoil surfaces; and (3) displacement and camber effects near the wake. These viscous effects in turn may influence aeroelastic characteristics. These effects can be accounted for by linking the inviscid calculations with boundary-layer corrections. Two viscous models, the viscous ramp and the Green lag-entrainment models were considered. Both the ramp model and the lag-entrainment equations, which were derived for steady-state computations, are incorporated in a quasi-steady fashion for unsteady computations. Thus, these viscous models may lose accuracy at higher frequencies.

Viscous computing capabilities were incorporated in the Boeing version of XTRAN3S by Rizzetta and Borland (ref. 16). By exercising that code, we noticed that the lift and moment results displayed high-frequency oscillations. This numerical instability was traced back to the incompatibilities in the procedure for computing the shock locations which are required to apply viscous corrections. Incompatibilities occurred because the three-dimensional shock profile was used to model the two-dimensional viscous corrections. In ATRAN3S, this instability was corrected by using a two-dimensional shock profile to model the two-dimensional viscous corrections. That correction eliminated the source of numerical instability in implementing the viscous wedge model in three-dimensional computations. With this modified viscous correction method, several computations were made for a rectangular and a transport-type wing; they are discussed in reference 17.

## Aeroelastic Computations

ATRAN3S can be used for both coupled (ref. 18) and uncoupled (ref. 8) aeroelastic computations. The simultaneous integration procedure developed for airfoils (refs. 19 and 20) has been extended to wings, and it is incorporated in the code.

## INPUT

The detailed input for the code is given in appendix A. Some important portions of the input are described in this section. The type of input used in XTRAN3S is not portable from computer to computer. In ATRAN3S, the input is in the form of NAMELIST, which is available on main frame computers such as the Cray, CYBER, and VAX.

### Grid

After transformation, the flow equations are solved in a Cartesian coordinate system. In any finite-difference scheme the grid plays an important role in obtaining the solution. The correct number of grid points and their proper distribution are essential. For the default grid system in the code, the grid is designed to obtain the best possible solution. The grid system has 64 points in the streamwise direction, 40 in the vertical direction, and 20 in the spanwise direction. The wing surface was defined by 39 points in the streamwise direction and 13 points in the spanwise direction. Computational boundaries are located as follows: the upstream boundary was at 15.4 chords; the downstream boundary was at 26.6 chords; the far-span boundary was at 1.6 semispan; and the far-field boundary was at 25.0 chords above the wing and at 25.0 chords below the wing. Grid points were generated such that the first and second derivatives of the grid lines were smooth. Plots of this grid in the $\xi$-$\eta$ plane and $\xi$-$\zeta$ plane are shown in figures 2 and 3, respectively. In figure 3, the grid is smoothly stretched in an exponential manner in the $\zeta$-direction away from the plane of the wing ($\zeta = 0$). This smooth stretching removes a deficiency of the original XTRAN3S grid in the $\zeta$-direction. In figure 2 it can be seen that in the interest of accuracy the grid is clustered near the leading and trailing edges in the $\xi$-direction. Also, grid boundaries are located far away from the wing to avoid boundary reflections. And again for accuracy, the grid spacing in the $\eta$-direction is fine near the tip.

### Convergence and Time-Step Size

Steady aerodynamic pressures are computed by integrating equation (5) in time and setting steady boundary conditions on the wing. ATRAN3S does not compute the residuals of the velocity potential to determine the convergence to a steady-state solution. Convergence can be determined by examining the pressure coefficient. The integration procedure may be stopped when the maximum pressure coefficient on the wing does not change by more than about 0.1% over 100 time-steps. This has given results that compare fairly well with experiment. The number of time-steps and the time-step size required for convergence depend mainly on the planform and the Mach number.

Unsteady aerodynamic forces are computed by having the wing undergo a given motion and then integrating the aerodynamic equation of motion in time. The code

has the capability of accounting for sinusoidal motion of rigid wings and for modal motions of flexible wings. In the many cases studied, it was found that about three cycles of motion are sufficient to obtain a periodic aerodynamic response. Periodicity was tested by comparing the Fourier coefficients of the responses between the second and third cycles. This feature of generating the Fourier coefficients as part of the ATRAN3S output data is an improvement over the original version of XTRAN3S.

## ILLUSTRATION

### Swept Tapered Wing

The original version of XTRAN3S was not adequate for fighter-type wings which are characterized by low aspect ratio, high sweep angle, and small taper ratio. For example, as shown in figure 4, the planform of the F-5 wing has an aspect ratio of 3.0, a taper ratio of 0.3, and a leading-edge sweep of 32°. Preliminary attempts made by using the earlier version of XTRAN3S (ref. 7) to obtain steady and unsteady results for this wing were not successful. The code was unstable even at the very small time-step size of 0.001, which is too small for routine use. At this time-step size, unsteady computations would require about 30,000 time-steps per cycle at a reduced frequency of 0.2. This failure was due to the conventional shearing transformation used in the original version of XTRAN3S. In the improved version, ATRAN3S, the problem was eliminated by using the modified shearing transformation (ref. 14).

Figure 5 shows the physical grid obtained from the conventional shearing transformation which made the flow computations unstable. The physical grid obtained by the modified transformation (ref. 14) is shown in figure 6, which has made the flow computations more stable and accurate. Figure 7 shows the plots of steady-pressure results obtained at $M = 0.9$ for the 50% semispan station. In spite of using a time-step size of 0.001, results from the conventional shearing transformation diverged before reaching 6,000 time-steps. Also, the results were highly inaccurate before diverging, as shown at 4,000 time-steps in figure 7. A converged solution was obtained by using 2,000 time-steps of size 0.01 with the modified shearing transformation. It can be seen that the latter method compares well with experiment (ref. 21). Plots of steady pressure distributions obtained by the modified transformation and experiment are given for four span stations in figure 8. Comparisons are good at all span stations.

Figure 9 shows the modal motion used in the NLR experiment (ref. 21) where the F-5 wing is pitching about an axis normal to the root chord and located at 50% of root chord. Figure 10 shows the plots of real and imaginary values of upper-surface pressures at four span stations obtained by the modified shearing transformation and the NLR experiment at $M = 0.9$ at a frequency of 40 Hz. The same modal motion used in the experiment was simulated in the code. Results from the code were obtained by oscillating the wing in a sinusoidal modal motion for three cycles, with

1,200 time-steps per cycle during which transients disappeared and a periodic response was obtained. Results from the code compare well with the experimental measurements (ref. 21). It is noted here that no attempt was made to use the conventional shearing transformation because of the diverged results in the steady calculations.

The input and output data for this case are given in appendix B.

## SALIENT PROGRAMMING FEATURES OF ATRAN3S

The complete ATRAN3S program is written in FORTRAN without any machine-dependent statements. The input and output processors in the original version depend on the computer, whereas in the Ames version they are independent of computers. The standard NAMELIST-type of input is used. The input can be very easily interfaced with any data-generation packages at the user end. The input can accept either coordinates or slopes of the wing surface instead of the polynomial representation required by the original version. Many options are provided in the output processor. The present output processor uses about 15% less computer time than that in XTRAN3S. Also it has some special features such as a Fourier analysis package for unsteady results. Finally, the ATRAN3S can handle both fighter- and transport-type wings.

At present the code is being exercised on a Cray X-MP. The memory required for a 64 × 40 × 20 grid is about 500K words. The code is operating at a speed of 8.92 μsec per grid point per operation on the Cray X-MP with a single processor. The code is easily portable to other computers.

# APPENDIX A

# DESCRIPTION OF ATRAN3S INPUT

FIRST CARD  Title written in 'A' FORMAT (Maximum 60 characters)
The rest of the INPUT is in NAMELIST format in the order described below

| NAMELIST | VARIABLE | TYPE | DEFAULT | DESCRIPTION |
|---|---|---|---|---|
| 1 NREST | | | | Restart condition data |
| | a) RESTRT | LOGI | FALSE | Flag to specify restart<br>TRUE - restart<br>FALSE - no restart |
| 2 NPRNT | | | | Flags to control output |
| | a) IPRFLG1 | INT | 0 | Flag for special debug output<br>0 - normal output<br>1 - debug output |
| | b) IPRFREP | INT | 1 | Pressure data print frequency (in time steps) |
| | c) IPRFREF | INT | 1 | Force data print freqency |
| | d) IPRFRED | INT | 1 | Displacement data print frequency |
| | e) IPLFRED | INT | 1 | Displacement plot data frequency |
| | f) SKIPCYC | INT | 0 | Pressure data print frequency (in cycles) |
| 3 NTASK | | | | Task type data |
| | a) TASK | HOLL | 'TASK3' | Control to specify type of task (static or dynamic)<br>'TASK2'- for static cases<br>'TASK3'- for dynamic case |
| | b) AEROTSK | HOLL | ' ' | Flag indicating aeroelastic solution<br>'FLEXIBLE' - solution is aero-elastic<br>' ' - solution not aero-elastic |
| 4 NFLWP | | | | Flow Parameters |
| | a) MACHNO | REAL | 0 8 | Mach Number |
| | b) UFS | REAL | 1 0 | Velocity |
| | c) GAMMA | REAL | 1 4 | Ratio of specific heats |
| | d) REDFREQ | REAL | 1 0 | Reduced frequency |
| 5 NITER | | | | Computational Parameters |
| | a) ITER | INT | 0 | Number of time steps completed (RESTART) |
| | b) MAXITS | INT | 0 | Maximum steady iterations |
| | c) MAXITD | INT | 1000 | Maximum unsteady iterations |
| | d) T | REAL | 0 0 | Time elapsed (RESTART) |
| | e) DELTAT | REAL | 0 1745329 | Time step size |
| 6 NEQUA | | | | Equation Parameters |

| | | | | |
|---|---|---|---|---|
| | a) EQ | HOLL | 'MODI' | Type of small disturbance equation<br>'MODI' - modified<br>'CLAS' - classical |
| | b) MODIFY | HOLL | 'AMES' | Type of coefficients in modified<br>'AMES' - Ames coefficients<br>'NLR ' - NLR coefficients |
| | c) FREQ | HOLL | 'HIGH' | Type of frequency approximation<br>'HIGH' - high frequency<br>'LOW ' - low frequency |
| 7 NMSXI | | | | X - Grid Lines (xi) |
| | a) NXIT | INT | 64 | Total number of grid lines |
| | b) NXIF | INT | 13 | No of upstream grid lines |
| | d) NXIA | INT | 12 | No of downstream grid lines (after Trailing Edge) |
| | c) XI | REAL | (Apndx A-1) | NXIT Values of grid lines |
| 8 NMSET | | | | Y - Grid Lines (eta) |
| | a) NETAT | INT | 20 | Total number of grid lines |
| | b) NETAIB | INT | 13 | Number of grid lines inboard of tip (inclusive) |
| | c) NETAOB | INT | 7 | Number of grid lines outboard of tip (exclusive) |
| | d) ETA | REAL | (Apndx A-1) | NETAT values of grid lines |
| 9 NMSHZ | | | | Z - Grid Lines (zeta) |
| | a) NZT | INT | 40 | Total number of grid lines |
| | b) NZU | INT | 20 | Grid lines above wing |
| | c) NZL | INT | 20 | Grid lines below wing |
| | d) ZETA | REAL | (Apndx A-1) | NZT values of grid lines |
| 10 NWPLN | | | | Planform data |
| | a) FORMAT | HOLL | 'RATIO' | Format of planform input<br>'RATIO' - planform is described as ratios |
| Note If FORMAT='RATIO' then following INPUT is required | | | | |
| | b) ARATIO | REAL | 4 0 | Aspect ratio |
| | c) TRATIO | REAL | 1 0 | Taper ratio |
| | d) SWANGL | REAL | 0 0 | Mean angle of attack in degrees |
| | e) NAIRSEC | INT | 2 | Number of sections at which airfoil sections are defined |
| | f) SLPINP | LOGI | FALSE | Flag to control type of airfoil section input<br>TRUE - sections are described by slopes<br>FALSE - sections are described by coordinates |

| | | | | |
|---|---|---|---|---|
| 11 NAIR | | | | Definition of airfoil section This NAMELIST data is repeated NAIRSEC times (see NAMELIST NWPLN) |
| | a) YVAL | REAL | 0.0 | Eta value of span station |
| | b) NINU | INT | 48 | Number of points on upper surface |
| | c) NINL | INT | 48 | Number of points on lower surface |
| | d) XINU | REAL | (Apndx A-2) | X-Coordinates for upper surface |
| | e) XINL | REAL | (Apndx A-2) | X-Coordinates for lower surface |
| | f) ZINU | REAL | (Apndx A-2) | Z-Coordinates or slopes for upper surface |
| | g) ZINL | REAL | (Apndx A-2) | Z-Coordinates or slopes for lower surface |
| 12 NDYN | | | | Boundary condition data |
| | a) MOTYPE | HOLL | 'MODA' | Flag indicating motion type<br>'SINU' - sinusoidal<br>'MODA' - modal |
| | b) SUBCASE | HOLL | ' ' | Flag indicating dynamic subcase to be executed when MOTYPE = 'SINU'<br>'PITC' - pitch<br>'PLUN' - plunge |
| The following data groups depend on value of MOTYPE | | | | |
| | Data for indicial motion (MOTYPE = 'INDI') | | | |
| | Ic) ALPHIM | REAL | 0 1 | Amplitude of indicial plunge effective angle (in degrees) |
| | Id) QSUBIM | REAL | 0 1 | Amplitude of indicial pitch (in degrees/second) |
| | Ie) XROTIM | REAL | 0 5 | X coordinate of axis rotation (fraction of reference chord) |
| | Data for sinusoidal motion (MOTYPE = 4LSINU) | | | |
| | When SUBCASE = 4LPLUN | | | |
| | Sc) OMEGSR | REAL | 0 2 | Frequency of plunging motion (in radians/sec ) |
| | Sd) H1SM | REAL | 0 1 | Amplitude of plunging motion (fraction of reference chord) |
| | Se) PHESP | REAL | 0 0 | Phase of plunging motion (in radians) |
| | When SUBCASE = 4LPITC | | | |
| | Sf) OMEGSP | REAL | 0 2 | Frequency of pitching motion (in radians/sec ) |
| | Sg) ALPHSM | REAL | 1 0 | Amplitude of pitching motion (in degrees) |
| | Sh) XROTSM | REAL | 0 5 | X-coordinate of axis of pitching (fraction of reference chord) |
| | Si) PHESR | REAL | 0 0 | Phase for sinusoidal motion (in radians) |
| | Data for modal motion (MOTYPE = 4LMODA) | | | |

| | | | | |
|---|---|---|---|---|
| Mc) | NMODES | INT | 1 | Number of modes in case (maximum = 20) |
| Md) | MODENO | INT | 1 | Index of current mode |
| Me) | FREQMD | REAL | 0 1 | Frequency of oscillation for sinusoidal motion of current mode (in radians) |
| Mf) | AMPMD | REAL | 1 0 | Amplitude of displacement for current mode |
| Mg) | PHASEMD | REAL | 0 0 | Phase of oscillation for current mode |

Note The following NAMELIST data should be present only if the motion type is modal (MOTYPE = 4LMODA) This data group is repeated NXIW (NXIT-NXIF-NXIA) times (see NAMELIST NMSXI)

13 NMODE — Numerical description of slopes and displacements

| | | | | |
|---|---|---|---|---|
| a) | MODEN | INTE | 0 | Mode sequence number |
| b) | ISPAN | INTE | 0 | Span station sequence number |
| c) | DDISP | REAL | NONE | Mode displacements mapped to XI grid on the wing |

Note The NAMELIST data entry features vector array filling, therefore it is not necessary to include zero values at the end of each vector array

14 NBUND — Boundary condition flags

| | | | | |
|---|---|---|---|---|
| a) | BCSYMM | HOLL | 'Y ' | Flag specifying configuration symmetry<br>'Y ' - Y=0 is plane of symmetry<br>'Z ' - Z=0 is plane of symmetry<br>'BOTH' - Y=0 and Z=0 are both planes of symmetry<br>'NONE' - Configuration has no symmetry |
| b) | DOWNST | HOLL | 'UNST' | Flag specifying downstream boundary condition<br>'STEA' - Downstream boundary condition is steady<br>'UNST' - Downstream boundary condition is unsteady |
| c) | FARFLD | HOLL | 'FREE' | Flag specifying farfield boundary condition<br>'FREE' - Farfield B C is freejet<br>'AIRF' - Farfield B C is airfoil<br>'KLUN' - Farfield B C is klunker |
| d) | LOWER | HOLL | 'ZERO' | Flag specifying lower farfield boundary condition<br>'ZERO' - Velocity at lower boundary is zero<br>'CALC' - Velocity at lower boundary is calculated |
| e) | UPPER | HOLL | 'ZERO' | Flag specifying upper farfield boundary condition<br>'ZERO' - Velocity at upper boundary is zero<br>'CALC' - Velocity at upper boundary is calculated |

| | | | | |
|---|---|---|---|---|
| f) UPSTRM | HOLL | 'FREE' | Flag specifying upstream boundary condition<br>'FREE' – Boundary condition is freestream (only choice) |
| g) WAKEBC | HOLL | 'UNST' | Flag specifying jump condition to be applied to potential across the wake<br>'STEA' – Steady jump condition to be applied<br>'UNST' – Unsteady jump condition to be applied |
| h) WALLS | HOLL | 'NONE' | Flag specifying wind tunnel wall boundary condition to be applied<br>'UPPE' – Walls are to be used for upper and lower boundaries<br>'SIDE' – Walls are to be used for side boundaries<br>'BOTH' – Walls are to be used for upper, lower and side boundaries<br>'NONE' – Walls are not used as boundaries |
| i) WINGBC | HOLL | 'UNST' | Flag specifying lifting surface boundary condition<br>'STEA' – Lifting surface B C is steady<br>'UNST' – Lifting surface B C is unsteady |

15 NANGL — Angles of attack

| | | | |
|---|---|---|---|
| a) ALPHREF | REAL | 0 0 | Rigid angle of attack |

16 NREFV — Geometry reference data

| | | | |
|---|---|---|---|
| a) SREF | REAL | 4 0 | Reference area |
| b) CBAR | REAL | 1 0 | Mean aerodynamic chord |
| c) XMOMC | REAL | 0 5 | Moment center reference |
| d) CREF | REAL | 1 0 | Reference chord |
| e) BREF | REAL | 3 0 | Reference span |
| f) XZERO | REAL | 0 5 | Moment reference variable |

Note The following four NAMELIST data should be present only if the solution is aeroelastic (AEROTSK = 'FLEXIBLE') NMODE is repeated NMAES * NETAIB times (see NAMELISTS NARO1 and NMSET)
NARO3 is repeated NMAES times (see NAMELIST NARO1)

17 NARO1 — Aeroelastic solution control data
Requried only if AEROTSK='FLEXIBLE'

| | | | |
|---|---|---|---|
| a) NMAES | INT | 5 | Number of generalized coordinates for the aeroelastic solution (maximum = 20) |
| b) NEFAES | INT | 20 | Number of points which have external forces defined in the aeroelastic solution (maximum = 20) |
| c) NSAES | INT | 50 | Number of structural degrees of freedom (maximum = 50) |
| d) NSUBZAE | REAL | 1 0 | Structural load factor |
| e) GRAVAE | REAL | 1 0 | Acceleration due to gravity |

| | | | | |
|---|---|---|---|---|
| | f) QAE | REAL | 1 0 | Dynamic pressure |
| | g) CSUBR | REAL | 1 0 | Reference chord for aeroelastic solution |
| 18 NMODE | | | | Aeroelastic modal displacements<br>Requried only if AEROTSK='FLEXIBLE' |
| | a) MODEN | INTE | 0 | Mode sequence number |
| | b) ISPAN | INTE | 0 | Span station sequence number |
| | c) DDISP | REAL | NONE | Mode displacements mapped to XI grid on the wing |
| 19 NARO2 | | | | Structural matrix data<br>Requried only if AEROTSK='FLEXIBLE' |
| | a) DMAE | REAL | no default | Generalized mass matrix |
| | b) DDAE | REAL | no default | Generalized damping matrix |
| | c) DKAE | REAL | no defalut | Generalized stiffness matrix |

Note It is not necessary to include zero values at the end of each vector array

| | | | | |
|---|---|---|---|---|
| 20 NARO3 | | | | Initial conditions generalised displacements<br>Requried only if AEROTSK='FLEXIBLE' |
| | a)GENP1 | REAL | 0 0 | Generalised displacements |
| | b)DGENP1 | REAL | 0 0 | Generalised velocities |
| | a)DDGENP1 | REAL | 0 0 | Generalised accelarations |
| 21 NVIS | | | | Boundary layer correction |
| | a) VISC | LOGI | FALSE | Viscous calculation indicator<br>TRUE - Yes<br>FALSE - No |
| | b) GREEN | LOGI | FALSE | Boundary layer indicator<br>TRUE - Yes<br>FALSE - No |
| | c) WEDGE | LOGI | FALSE | Wedge calculation indicator<br>TRUE - Yes<br>FALSE - No |
| | d) READV | LOGI | FALSE | Viscous restart indicator<br>TRUE - On<br>FALSE - Off |
| | e) IBLCN | INT | 0 | Boundary layer calculation counter |
| | f) IBLPN | INT | 0 | Boundary layer print counter |
| | g) IBLCAL | INT | 1 | Boundary layer calculation interval |
| | h) IBLPRT | INT | 50 | Boundary layer print interval |
| | i) XOFFST | REAL | 0 02 | Ramp shock offset length |
| | j) XPREC | REAL | 0 02 | Ramp precursor length |
| | k) XRAMP | REAL | 0 10 | Ramp length |

APPENDIX A-1 DEFAULT GRID VALUES

| XI VALUES | | | | ETA VALUES | | ZETA VALUES | |
|---|---|---|---|---|---|---|---|
| I | XI | I | XI | J | Y | K | Z |

| | | | |
|---|---|---|---|
| 1 | -15 3750 | 33 | 0.4600 |
| 2 | -8 1079 | 34 | 0 4900 |
| 3 | -4 2473 | 35 | 0 5200 |
| 4 | -2 2050 | 36 | 0 5500 |
| 5 | -1 1318 | 37 | 0 5800 |
| 6 | -0 5737 | 38 | 0 6100 |
| 7 | -0 2881 | 39 | 0 6400 |
| 8 | -0 1453 | 40 | 0 6700 |
| 9 | -0 0758 | 41 | 0 7000 |
| 10 | -0 0426 | 42 | 0 7300 |
| 11 | -0 0259 | 43 | 0 7600 |
| 12 | -0 0151 | 44 | 0 7900 |
| 13 | -0 0050 | 45 | 0 8199 |
| 14 | 0 0050 | 46 | 0 8497 |
| 15 | 0 0151 | 47 | 0 8788 |
| 16 | 0 0254 | 48 | 0 9066 |
| 17 | 0 0365 | 49 | 0 9326 |
| 18 | 0 0494 | 50 | 0 9566 |
| 19 | 0 0649 | 51 | 0 9788 |
| 20 | 0 0839 | 52 | 1 0000 |
| 21 | 0 1065 | 53 | 1 0219 |
| 22 | 0 1324 | 54 | 1 0516 |
| 23 | 0 1607 | 55 | 1 1037 |
| 24 | 0 1901 | 56 | 1 2036 |
| 25 | 0 2200 | 57 | 1 3947 |
| 26 | 0 2500 | 58 | 1 7521 |
| 27 | 0 2800 | 59 | 2 4048 |
| 28 | 0 3100 | 60 | 3 5750 |
| 29 | 0 3400 | 61 | 5 6456 |
| 30 | 0 3700 | 62 | 9 2758 |
| 31 | 0 4000 | 63 | 15 6006 |
| 32 | 0 4300 | 64 | 26 5750 |

| | |
|---|---|
| 1 | -0 2000 |
| 2 | 0 0000 |
| 3 | 0 2000 |
| 4 | 0 4000 |
| 5 | 0 6000 |
| 6 | 0 8000 |
| 7 | 0 9999 |
| 8 | 1 1989 |
| 9 | 1 3931 |
| 10 | 1 5736 |
| 11 | 1 7289 |
| 12 | 1 8536 |
| 13 | 1 9535 |
| 14 | 2 0419 |
| 15 | 2 1357 |
| 16 | 2 2605 |
| 17 | 2 4632 |
| 18 | 2 8085 |
| 19 | 3 3363 |
| 20 | 4 0000 |

| | |
|---|---|
| 1 | -24 9140 |
| 2 | -13 6750 |
| 3 | -7 7280 |
| 4 | -4 5020 |
| 5 | -2 7060 |
| 6 | -1 6800 |
| 7 | -1 0780 |
| 8 | -0 7140 |
| 9 | -0 4880 |
| 10 | -0 3440 |
| 11 | -0 2480 |
| 12 | -0 1840 |
| 13 | -0 1380 |
| 14 | -0 1050 |
| 15 | -0 0800 |
| 16 | -0 0610 |
| 17 | -0 0450 |
| 18 | -0 0320 |
| 19 | -0 0200 |
| 20 | -0 0100 |
| 21 | 0 0100 |
| 22 | 0 0200 |
| 23 | 0 0320 |
| 24 | 0 0450 |
| 25 | 0 0610 |
| 26 | 0 0800 |
| 27 | 0 1050 |
| 28 | 0 1380 |
| 29 | 0 1840 |
| 30 | 0 2480 |
| 31 | 0 3440 |
| 32 | 0 4880 |
| 33 | 0 7140 |
| 34 | 1 0780 |
| 35 | 1 6800 |
| 36 | 2 7060 |
| 37 | 4 5020 |
| 38 | 7 7280 |
| 39 | 13 6750 |
| 40 | 24 9140 |

# APPENDIX B

## ATRAN3S INPUT/OUTPUT FOR F-5 WING UNDERGOING MODAL OSCILLATIONS

```
 THE F-5 WING UNDERGOING MODAL OSCILLATIONS AT M=0 9 AND K = 0 55(40HZ)
$NREST RESTRT= FALSE $
$NPRNT IPRFLG1=0,IPRFREP=1000,IPRFREF=1000,IPRFRED=1,IPLFRED=1,SKIPCYC=0 $
$NTASK TASK='TASK3'  $
$NFLWP MACHNO = 0 90,GAMMA=1 4$
$NITER MAXITS=0,MAXITD=3500,ITER=0,T=0 0,DELTAT = 0.01  $
$NEQUA FREQ=4LHIGH  $
$NMSXI
 NXIT=64,NXIF=13,NXIA=12,
 XI= -15 37500,-8 10791,-4 24734,-2 20500,-1 13177,
   -0 57371,-0 28812,-0 14526,-0 07579,-0 04260,
   -0 02589,-0 01506,-0 00500
    0 00500,0 01506,0 02539,0 03653,0 04938,
    0 06493,0 08391,0 10654,0 13245,0 16067,
    0 19012,0 22001,0 25000,0 28000,0 31000,
    0 34000,0 37000,0 40000,0 43000,0 46000,
    0 49000,0 52000,0 55000 0 58000,0 61000,
    0 64000,0 67000,0 70000,0 73000,0 76000,
    0 79000,0 81994,0 84966,0 87875,0 90659,
    0 93262,0 95660,0 97881,
    1 00000,1 02188,1 05155,1 10369,1 20357,
    1 39472,1 75209,2 40476,3 57502,5 64564,
    9 27579,15 60064,26 57500$
$NMSET NETAOB= 7,NETAIB=13,
 ETA=  -0 0973,0 0000,0 0973,0 1947,0 2920,0 3894,0 4867,
 0 5835,0 6780,0 7659,0 8415,0 9022,0 9508,
 0 9938,1 0394,1 1002,1 1988,1 3669,1 6238,1 9468 $
$NMSHZ  ZETA= -24 914, -13 675, -7 728, -4 502, -2 706, -1 680,-1 078,-0 714,
 -0 488,-0 344,-0 248,-0 184,-0 138,-0 105,-0 080,-0 061,-0 045,-0 032,-0 020,
 -0 010,0 010,0 020,0 032,0 045,0 061,0 080,0 105,0 138,0 184 0 248
 0 344 0 488,0 714,1 078,1 680,2 706,4 502,7 728,13 675,24 914 $
$NWPLN FORMAT='RATIO',ARATIO = 2 9768,TRATIO=0 308,SWANGL=31 917,NAIRSEC=2,
       SLPINP= TRUE $
$NAIR YVAL=0 00,NINU=39,NINL=39,
  XINU=0 005,0 015,0 025,0 035,0 045,0 060,0 080,0 100,0 130,
       0 160,0 190,0 220,0 250,0 280,0 310,0 340,0 370,0 400,
       0 430,0 460,0 490,0 520,0 550,0 580,0 610,0 640,0 670,
       0 700,0 730,0 760,0 790,0 820,0 850,0 880,0 910,0 935,
       0 960,0 980,1 000,
   XINL=0 005,0 015,0 025,0 035,0 045,0 060,0 080,0 100,0 130,
       0 160,0 190 0 220 0 250,0 280 0 310,0 340,0 370,0 400
       0 430,0 460,0 490,0 520,0 550,0 580,0 610,0 640,0 670,
       0 700,0 730 0 760,0 790,0 820 0 850,0 880,0 910,0 935,
       0 960,0 980,1 000,
    ZINU=0 31365,0 23291,0 20255 0 18295,0 16790,
    0 14974,0 13017,0 11384,0 09336,0 07637,
    0 06202,0 04978,0 03925,0 03012,0 02214,
    0 01508,0 00875,0 00300,-0 00233,-0 00733,
    -0 01212,-0 01676,-0 02130,-0 02580,-0 03026,
    -0 03469,-0 03905,-0 04333,-0 04745 -0 05134,
    -0 05492,-0 05806,-0 06065,-0 06252,-0 06352,
    -0 06356,-0 06274,-0 06139,-0 05935,
    ZINL=-0 27687,-0 11999,-0 07540,-0 05394,-0 04169
    -0 03137,-0 02474,-0 02184,-0 02041,-0 02020
    -0 02009,-0 01960,-0 01852,-0 01677,-0 01438,
    -0 01137,-0 00780,-0 00377,0 00065,0 00537
    0 01030,0 01537,0 02049,0 02558,0 03056,
```

```
   0 03538,0 03997,0 04427,0 04823,0.05181,
   0 05496,0 05765,0 05986,0 06157,0 06275
   0 06334,0 06356,0 06348,0 06316$
 $NAIR YVAL=0 9734,NINU=39,NINL=39,
   XINU=0 005,0 015,0 025,0 035,0 045,0 060,0 080,0 100,0 130,
       0 160,0 190,0 220,0 250,0 280,0 310,0 340,0 370,0 400,
       0 430,0 460,0 490,0 520,0 550,0 580,0 610,0 640,0 670,
       0 700,0 730,0 760,0 790,0 820,0 850,0 880,0 910,0 935,
       0 960,0 980,1 000,
   XINL=0 005,0 015,0 025,0 035,0 045,0 060,0 080,0 100,0 130,
       0 160,0 190,0 220,0 250,0 280,0 310,0 340,0 370,0 400,
       0 430,0 460,0 490,0 520,0 550,0 580,0 610,0 640,0 670,
       0 700,0 730,0 760,0 790,0 820,0 850,0 880,0 910,0 935,
       0 960,0 980,1 000,
    ZINU=0 31365,0 23291,0 20255,0 18295,0 16790,
    0 14974,0 13017,0 11384 0 09336,0 07637,
    0 06202,0 04978,0 03925,0 03012,0 02214,
    0 01508,0 00875,0 00300,-0 00233,-0 00733,
    -0 01212,-0 01676,-0 02130,-0 02580,-0 03026,
    -0 03469,-0 03905,-0 04333,-0 04745,-0 05134,
    -0 05492,-0 05806,-0 06065,-0 06252,-0 06352,
    -0 06356,-0 06274,-0 06139,-0 05935,
    ZINL=-0 27687,-0 11999,-0 07540,-0 05394,-0 04169,
    -0 03137,-0 02474,-0 02184,-0 02041,-0 02020,
    -0 02009,-0 01960,-0 01852,-0 01677,-0 01438,
    -0 01137,-0 00780,-0 00377,0 00065,0 00537,
    0 01030,0 01537,0 02049,0 02558,0 03056,
    0 03538,0 03997,0 04427,0 04823,0 05181,
    0 05496,0 05765,0 05986,0 06157,0 06275,
    0 06334,0 06356,0 06348,0 06316$
$NDYN MOTYPE=4LMODA,FREQMD=0 550,AMPMD=1 0,PHASEMD=0 0 $
 $NMODE DDISP =
      -0 00652,  -0 00650,  -0 00650,  -0 00649,  -0 00646,
 -0 00641,  -0 00632,  -0 00618,  -0 00599,  -0 00575,
 -0 00546,  -0 00515,  -0 00346,  -0 00308,  -0 00271,
 -0 00233,  -0 00196,  -0 00158,  -0 00121,  -0 00083,
 -0 00046,  -0 00010,   0 00026,   0 00060,   0 00095,
  0 00128,   0 00161,   0 00193,   0 00225,   0 00257,
  0 00291,   0 00327,   0 00404,   0 00440,   0 00475,
  0 00508,   0 00538,   0 00565,   0 00592,
 DSLOP =
       0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
  0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
  0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
  0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
  0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
  0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
  0 01184,   0 01184,   0 01184,   0 01184,
  $
 $NMODE DDISP =
      -0 00652,  -0 00650,  -0 00650,  -0 00649,  -0 00646,
 -0 00641,  -0 00632,  -0 00618,  -0 00599,  -0 00575,
 -0 00546,  -0 00515,  -0 00346,  -0 00308,  -0 00271,
 -0 00233,  -0 00196,  -0 00158,  -0 00121,  -0 00083,
 -0 00046,  -0 00010,   0 00026,   0 00060,   0 00095,
  0 00128,   0 00161,   0 00193,   0 00225,   0 00257,
  0 00291,   0 00327,   0 00404,   0 00440,   0 00475,
  0 00508,   0 00538,   0 00565,   0 00592,
 DSLOP =
       0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
```

```
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00576,  -0 00575,  -0 00574,  -0 00573,  -0 00571,
-0 00566,  -0 00558,  -0 00545,  -0 00528   -0 00506
-0 00480,  -0 00451,  -0 00291,  -0 00257,  -0 00222,
-0 00187,  -0 00152,  -0 00117,  -0 00082,  -0 00047,
-0 00012,   0 00021,   0 00055,   0 00087,   0 00119,
 0 00150,   0 00180,   0 00209,   0 00239,   0 00268,
 0 00300,   0 00332,   0 00406,   0 00440,   0 00472,
 0 00503,   0 00531,   0 00556,   0 00581,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00501,  -0 00499,  -0 00498,  -0 00497,  -0 00495,
-0 00491,  -0 00484,  -0 00473,  -0 00458,  -0 00438,
-0 00414,  -0 00388,  -0 00237,  -0 00205,  -0 00173,
-0 00140,  -0 00108,  -0 00076,  -0 00043,  -0 00011,
 0 00021,   0 00053,   0 00084,   0 00114,   0 00143,
 0 00172,   0 00199,   0 00226,   0 00253,   0 00280,
 0 00308,   0 00337,   0 00409,   0 00440,   0 00470,
 0 00498,   0 00524,   0 00548,   0 00570,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184    0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184    0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00426,  -0 00424,  -0 00422,  -0 00421,  -0 00420,
-0 00416,  -0 00410,  -0 00400,  -0 00387,  -0 00369,
-0 00348,  -0 00324,  -0 00183,  -0 00153,  -0 00124,
-0 00094,  -0 00064,  -0 00035,  -0 00005,   0 00025,
 0 00055,   0 00084,   0 00113,   0 00141,   0 00167,
 0 00193,   0 00218,   0 00243,   0 00266,   0 00291,
 0 00316,   0 00343,   0 00411,   0 00440,   0 00467,
 0 00493,   0 00517,   0 00539,   0 00560,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
```

```
 0 01184,   0 01184,   0.01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00350,  -0 00348,  -0 00347,  -0 00346,  -0 00344,
-0 00341,  -0 00336,  -0 00328,  -0 00316,  -0 00301,
-0 00282,  -0 00261,  -0 00129,  -0 00102,  -0 00075,
-0 00048,  -0 00021,   0 00007,   0 00034,   0 00061,
 0 00088,   0 00115,   0 00142,   0 00167,   0 00192,
 0 00215,   0 00238,   0 00259,   0 00280,   0 00302,
 0 00324,   0 00348,   0 00413,   0 00439,   0 00464,
 0 00488,   0 00510,   0 00530,   0 00549,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0.01184,   0.01184,   0.01184,   0.01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00275,  -0 00272,  -0 00271,  -0 00270,  -0 00269,
-0 00266,  -0 00262,  -0 00255,  -0 00245,  -0 00232,
-0 00216,  -0 00198,  -0 00075,  -0 00050,  -0 00026,
-0 00001,   0 00023,   0 00048,   0 00072,   0 00097,
 0 00121,   0 00146,   0 00171,   0 00194,   0 00216,
 0 00237,   0 00257,   0 00276,   0 00294,   0 00313,
 0 00333,   0 00354,   0 00415,   0 00439,   0 00462,
 0 00483,   0 00503,   0 00521,   0 00538,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0.01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00200,  -0 00197,  -0 00196,  -0 00194,  -0 00193,
-0 00192,  -0 00188,  -0 00183,  -0 00175,  -0 00164,
-0 00151,  -0 00135,  -0 00021,   0 00001,   0 00023,
 0 00045,   0 00067,   0 00089,   0 00111,   0 00133,
 0 00155,   0 00178,   0 00200,   0 00220,   0 00240,
 0 00259,   0 00276,   0 00292,   0 00308,   0 00324,
 0 00341,   0 00359,   0 00418,   0 00439,   0 00459,
 0 00478,   0 00496,   0 00512,   0 00528,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184
 0 01184,   0 01184,   0 01184,   0 01184,
 $
```

```
$NMODE DDISP =
     -0 00127,  -0 00124,  -0 00122,  -0 00121,  -0 00120,
-0 00119,  -0 00116,  -0 00112,  -0 00106,  -0 00098,
-0 00086,  -0 00073,   0 00032,   0 00051,   0 00070,
 0 00090,   0 00109,   0 00129,   0 00148,   0 00168,
 0 00187,   0 00208,   0 00228,   0 00246,   0 00264,
 0 00280,   0 00295,   0 00308,   0 00321,   0 00335,
 0 00349,   0 00364,   0 00420,   0 00439,   0 00457,
 0 00474,   0 00489,   0 00503,   0 00517,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
     -0 00059,  -0 00056,  -0 00054,  -0 00053,  -0 00052,
-0 00051,  -0 00050,  -0 00047,  -0 00042,  -0 00036,
-0 00027,  -0 00016,   0 00080,   0 00098,   0 00115,
 0 00132,   0 00149,   0 00166,   0 00183,   0 00200,
 0 00217,   0 00236,   0 00254,   0 00270,   0 00286,
 0 00299,   0 00312,   0 00323,   0 00334,   0 00345,
 0 00356,   0 00369,   0 00422,   0 00438,   0 00454,
 0 00469,   0 00483,   0 00495,   0 00507,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184    0 01184,   0 01184,
 0 01184,   0 01184    0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
      0 00000,   0 00003,   0 00005,   0 00006,   0 00007,
 0 00007,   0 00008,   0 00010,   0 00012,   0 00017,
 0 00025,   0 00033,   0 00123,   0 00138,   0 00153,
 0 00168,   0 00183,   0 00198,   0 00213,   0 00228,
 0 00243,   0 00260,   0 00277,   0 00291,   0 00305,
 0 00316,   0 00327,   0 00336,   0 00345,   0 00353,
 0 00363,   0 00373,   0 00424,   0 00438,   0 00452,
 0 00465,   0 00477,   0 00489,   0 00499,
DSLOP =
      0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,   0 01184,
 0 01184,   0 01184,   0 01184,   0 01184,
 $
$NMODE DDISP =
      0 00046,   0 00050,   0 00052,   0 00054,   0 00054,
 0 00054,   0 00054,   0 00055,   0 00057,   0 00060,
 0 00066,   0 00073,   0 00156,   0 00170,   0 00183,
```

```
  0 00197,    0 00210,    0 00224,    0 00237,    0 00250,
  0 00264,    0 00280,    0 00295,    0 00308,    0 00320,
  0 00330,    0 00339,    0 00346,    0 00353,    0 00360,
  0 00368,    0 00377,    0 00425,    0 00438,    0 00451,
  0 00462,    0 00473,    0 00483,    0 00492,
 DSLOP =
       0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0.01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,
  $
 $NMODE DDISP =
       0 00084,    0 00088,    0 00090,    0 00091,    0 00092,
  0 00091,    0 00091,    0 00091,    0 00092,    0 00094,
  0 00099,    0 00105,    0 00183,    0 00196,    0 00208,
  0 00220,    0 00232,    0 00244,    0 00256,    0 00268,
  0 00281,    0 00296,    0 00309,    0 00321,    0 00332,
  0 00341,    0 00349,    0 00355,    0 00360,    0 00366,
  0 00372,    0 00380,    0 00426,    0 00438,    0 00449,
  0 00460,    0 00470,    0 00479,    0 00487,
 DSLOP =
       0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,    0 01184,
  0 01184,    0 01184,    0 01184,    0 01184,
  $
 $NBUND DOWNST=4LSTEA,WINGBC=4LUNST,WAKEBC=4LUNST  $
 $NANGL $
 $NREFV SREF=2 9768, XMOMC=0 5,CREF=1 0,BREF=1 9468,XZERO=0 5,CBAR=1 0  $
 $NVIS VISC= FALSE ,WEDGE= FALSE ,GREEN= FALSE ,REYINF=10 0E7,IBLPRT=450 $
/EOF
```

********** SAMPLE OUTPUT FROM ATRAN3S **********

APPLIED COMPUTATIONAL AERODYNAMICS BRANCH

NASA - AMES RESEARCH CENTER

MOFFETT FIELD, CA 94035

PROGRAM ATRAN3S

(THE AMES VERSION OF THE AIRFORCE-BOEING XTRAN3S)

A UNSTEADY TRANSONIC AERODYNAMICS CODE FOR AEROELASTIC ANALYSIS OF WINGS

WRITTEN BY

DR GURU P GURUSWAMY
(415) 694 6329

AND

DR PETER M GOORJIAN
(415) 694 5547

1 CASE 370 M=0 9 K=0 275 (40HZ)

FLAGS TO CONTROL OUTPUT

| | |
|---|---|
| DETAILED PRINT FLAG = | 0 |
| PRESSURE PRINT FREQUENCY = | 1000 |
| FORCE COEFFICIENT PRINT FREQUENCY = | 1000 |
| DISPLACEMENT PRINT FREQUENCY = | 1 |
| DISPLACEMENT PLOT DATA FREQUENCY = | 1 |
| NUMBER OF CYCLES OF INPUT SUPRESSION = | 0 |

TASK = DYNAMIC ANALYSIS

FLOW PARAMETERS

| | |
|---|---|
| FREE STREAM MACH NUMBER = | 0 9000 |
| FREE STREAM VELOCITY = | 1 0000 |
| RATIO OF SPECIFIC HEATS = | 1 4000 |
| TIME SCALE = | 1 0000 |

COMPUTATION PARAMETERS

| | |
|---|---|
| ITERATIONS COMPLETED = | 0 |

```
     MAXIMUM STEADY ITERATIONS =       0
     MAXIMUM UNSTEADY ITERATIONS =  3500
     TIME ELAPSED =              0 000000
     TIME STEP SIZE =            0 010000
0EQUATION PARAMETERS

     EQUATION TYPE = MODIFIED SMALL DISTURBANCE
     FREQUENCY = HIGH FREQUENCY APPROXIMATION
     MODIFY = AMES COEFFICIENTS
1GRID SPECIFICATIONS


 XI GRID

     TOTAL NUMBER OF POINTS =                  64
     NUMBER OF  POINTS FORWARD OF L E =        13
     NUMBER OF POINTS ON WING =                39
     NUMBER OF  POINTS AFTER T E =             12
     INDEX OF FIRST POINT ON WING =            14
     LENGTH OF MESH IN FRONT OF L E =    15 37500
     TOTAL LENGTH OF  MESH =             41 95000
     MESH SPACING AT L E =                0 01000
     MESH SPACING AT T E =                0 02119
     MAXIMUM MESH SPACING =              10 97436


 ETA GRID

     TOTAL NUMBER OF  POINTS =                              20
     INDEX OF FIRST  POINT =                                 1
     NUMBER OF  POINTS INBOARD OF WING  TIP =               13
     NUMBER OF POINTS OUTBOARD OF WING TIP =                 7
     TOTAL NUMBER OF MESHPOINTS ON WING =                   13
     TOTAL LENGTH OF MESH =                           1 94680
     LENGTH OF MESH INBOARD OF WING TIP =             0 95080
     LENGTH OF MESH OUTBOARD OF WING TIP =            0 99600
     MESH SPACING AT WING ROOT =                      0 09730
     MESH SPACING AT TIP =                            0 04860
     MAXIMUM MESH SPACING (AT FAR SPAN BOUNDARY) =    0 32300


 ZETA GRID

     TOTAL NUMBER OF ZETA GRID POINTS =                      40
     INDEX OF ZETA GRID POINT IMMEDIATELY ABOVE WING =       21
     INDEX OF ZETA GRID POINT IMMEDIATELY BELOW WING =       20
     NUMBER OF ZETA GRID POINTS BELOW WING =                 20
     NUMBER OF ZETA GRID POINTS ABOVE WING =                 20
     TOTAL LENGTH OF MESH =                          49 82800
     LENGTH OF MESH  ABOVE WING =                    24 91400
     LENGTH OF MESH BELOW WING =                     24 91400
     SPACING AT UPPER BOUNDARY =                     11 23900
     SPACING AT LOWER BOUNDARY =                     11 23900
     SPACING AT WING =                                0 02000
1GRID POINTS

     INDEX      XI              INDEX     ETA              INDEX     ZETA

        1   -15 37500              1    -0 09730             1   -24 91400
        2    -8 10791              2     0 00000             2   -13 67500
        3    -4 24734              3     0 09730             3    -7.72800
```

| | | | | | |
|---|---|---|---|---|---|
| 4 | -2 20500 | 4 | 0.19470 | 4 | -4 50200 |
| 5 | -1 13177 | 5 | 0 29200 | 5 | -2 70600 |
| 6 | -0 57371 | 6 | 0 38940 | 6 | -1 68000 |
| 7 | -0 28812 | 7 | 0 48670 | 7 | -1 07800 |
| 8 | -0 14526 | 8 | 0 58350 | 8 | -0 71400 |
| 9 | -0 07579 | 9 | 0 67800 | 9 | -0 48800 |
| 10 | -0 04260 | 10 | 0 76590 | 10 | -0 34400 |
| 11 | -0 02589 | 11 | 0 84150 | 11 | -0 24800 |
| 12 | -0 01506 | 12 | 0 90220 | 12 | -0 18400 |
| 13 | -0 00500 | 13 | 0 95080 | 13 | -0 13800 |
| 14 | 0 00500 | 14 | 0 99380 | 14 | -0 10500 |
| 15 | 0 01506 | 15 | 1 03940 | 15 | -0 08000 |
| 16 | 0 02539 | 16 | 1 10020 | 16 | -0 06100 |
| 17 | 0 03653 | 17 | 1 19880 | 17 | -0 04500 |
| 18 | 0 04938 | 18 | 1.36690 | 18 | -0 03200 |
| 19 | 0 06493 | 19 | 1 62380 | 19 | -0 02000 |
| 20 | 0 08391 | 20 | 1 94680 | 20 | -0 01000 |
| 21 | 0 10654 | | | 21 | 0 01000 |
| 22 | 0 13245 | | | 22 | 0 02000 |
| 23 | 0 16067 | | | 23 | 0 03200 |
| 24 | 0 19012 | | | 24 | 0 04500 |
| 25 | 0 22001 | | | 25 | 0 06100 |
| 26 | 0 25000 | | | 26 | 0 08000 |
| 27 | 0 28000 | | | 27 | 0 10500 |
| 28 | 0 31000 | | | 28 | 0 13800 |
| 29 | 0 34000 | | | 29 | 0 18400 |
| 30 | 0 37000 | | | 30 | 0 24800 |
| 31 | 0 40000 | | | 31 | 0 34400 |
| 32 | 0 43000 | | | 32 | 0 48800 |
| 33 | 0 46000 | | | 33 | 0 71400 |
| 34 | 0 49000 | | | 34 | 1 07800 |
| 35 | 0 52000 | | | 35 | 1 68000 |
| 36 | 0 55000 | | | 36 | 2 70600 |
| 37 | 0 58000 | | | 37 | 4 50200 |
| 38 | 0 61000 | | | 38 | 7 72800 |
| 39 | 0 64000 | | | 39 | 13 67500 |
| 40 | 0 67000 | | | 40 | 24.91400 |
| 41 | 0 70000 | | | | |
| 42 | 0 73000 | | | | |
| 43 | 0 76000 | | | | |
| 44 | 0 79000 | | | | |
| 45 | 0 81994 | | | | |
| 46 | 0 84966 | | | | |
| 47 | 0 87875 | | | | |
| 48 | 0 90659 | | | | |
| 49 | 0 93262 | | | | |
| 50 | 0 95660 | | | | |
| 51 | 0 97881 | | | | |
| 52 | 1 00000 | | | | |
| 53 | 1 02188 | | | | |
| 54 | 1 05155 | | | | |
| 55 | 1 10369 | | | | |
| 56 | 1 20357 | | | | |
| 57 | 1 39472 | | | | |
| 58 | 1 75209 | | | | |
| 59 | 2 40476 | | | | |
| 60 | 3 57502 | | | | |
| 61 | 5 64564 | | | | |
| 62 | 9 27579 | | | | |
| 63 | 15 60064 | | | | |

64 26.57500

PLANFORM DESCRIPTION

FORMAT = RATIO

ASPECT RATIO = 2 98

TAPER RATIO = 0 31

SWEEP ANGLE (DEGREES) = 31 92

NUMBER OF AIRFOIL SECTIONS = 2

INPUT IS IN THE FORM OF SLOPES
1INPUT AIRFOIL GEOMETRY FOR SECTION NO = 1 AT ETA = 0 00000

| UPPER SURFACE | | | LOWER SURFACE | | |
|---|---|---|---|---|---|
| INDEX | X | Z | INDEX | X | Z |
| 1 | 0 00500 | 0 31365 | 1 | 0 00500 | -0 27687 |
| 2 | 0 01500 | 0 23291 | 2 | 0 01500 | -0 11999 |
| 3 | 0 02500 | 0 20255 | 3 | 0 02500 | -0 07540 |
| 4 | 0 03500 | 0 18295 | 4 | 0 03500 | -0 05394 |
| 5 | 0 04500 | 0 16790 | 5 | 0 04500 | -0 04169 |
| 6 | 0 06000 | 0 14974 | 6 | 0 06000 | -0 03137 |
| 7 | 0 08000 | 0 13017 | 7 | 0 08000 | -0 02474 |
| 8 | 0 10000 | 0 11384 | 8 | 0 10000 | -0 02184 |
| 9 | 0 13000 | 0 09336 | 9 | 0 13000 | -0 02041 |
| 10 | 0 16000 | 0 07637 | 10 | 0 16000 | -0 02020 |
| 11 | 0 19000 | 0 06202 | 11 | 0 19000 | -0 02009 |
| 12 | 0 22000 | 0 04978 | 12 | 0 22000 | -0 01960 |
| 13 | 0 25000 | 0 03925 | 13 | 0 25000 | -0 01852 |
| 14 | 0 28000 | 0 03012 | 14 | 0 28000 | -0 01677 |
| 15 | 0 31000 | 0 02214 | 15 | 0 31000 | -0 01438 |
| 16 | 0 34000 | 0 01508 | 16 | 0 34000 | -0 01137 |
| 17 | 0 37000 | 0 00875 | 17 | 0 37000 | -0 00780 |
| 18 | 0 40000 | 0 00300 | 18 | 0 40000 | -0 00377 |
| 19 | 0 43000 | -0 00233 | 19 | 0 43000 | 0 00065 |
| 20 | 0 46000 | -0 00733 | 20 | 0 46000 | 0 00537 |
| 21 | 0 49000 | -0 01212 | 21 | 0 49000 | 0 01030 |
| 22 | 0 52000 | -0 01676 | 22 | 0 52000 | 0 01537 |
| 23 | 0 55000 | -0 02130 | 23 | 0 55000 | 0 02049 |
| 24 | 0 58000 | -0 02580 | 24 | 0 58000 | 0 02558 |
| 25 | 0 61000 | -0 03026 | 25 | 0 61000 | 0 03056 |
| 26 | 0 64000 | -0 03469 | 26 | 0 64000 | 0 03538 |
| 27 | 0 67000 | -0 03905 | 27 | 0 67000 | 0 03997 |
| 28 | 0 70000 | -0 04333 | 28 | 0 70000 | 0 04427 |
| 29 | 0 73000 | -0 04745 | 29 | 0 73000 | 0 04823 |
| 30 | 0 76000 | -0 05134 | 30 | 0 76000 | 0 05181 |
| 31 | 0 79000 | -0 05492 | 31 | 0 79000 | 0 05496 |
| 32 | 0 82000 | -0 05806 | 32 | 0 82000 | 0 05765 |
| 33 | 0 85000 | -0 06065 | 33 | 0 85000 | 0 05986 |
| 34 | 0 88000 | -0 06252 | 34 | 0 88000 | 0 06157 |
| 35 | 0 91000 | -0 06352 | 35 | 0 91000 | 0 06275 |
| 36 | 0 93500 | -0 06356 | 36 | 0 93500 | 0 06334 |
| 37 | 0 96000 | -0 06274 | 37 | 0 96000 | 0 06356 |
| 38 | 0 98000 | -0 06139 | 38 | 0 98000 | 0 06348 |

```
      39   1 00000  -0 05935         39   1 00000   0 06316
1INPUT AIRFOIL GEOMETRY FOR SECTION NO  =    2 AT ETA =    0 97340
```

| UPPER SURFACE | | | LOWER SURFACE | | |
|---|---|---|---|---|---|
| INDEX | X | Z | INDEX | X | Z |
| 1 | 0 00500 | 0 31365 | 1 | 0 00500 | -0 27687 |
| 2 | 0 01500 | 0 23291 | 2 | 0 01500 | -0 11999 |
| 3 | 0 02500 | 0 20255 | 3 | 0 02500 | -0 07540 |
| 4 | 0 03500 | 0 18295 | 4 | 0 03500 | -0 05394 |
| 5 | 0 04500 | 0 16790 | 5 | 0 04500 | -0 04169 |
| 6 | 0 06000 | 0 14974 | 6 | 0 06000 | -0 03137 |
| 7 | 0 08000 | 0 13017 | 7 | 0 08000 | -0 02474 |
| 8 | 0 10000 | 0 11384 | 8 | 0 10000 | -0 02184 |
| 9 | 0 13000 | 0 09336 | 9 | 0 13000 | -0 02041 |
| 10 | 0 16000 | 0 07637 | 10 | 0 16000 | -0 02020 |
| 11 | 0 19000 | 0 06202 | 11 | 0 19000 | -0 02009 |
| 12 | 0 22000 | 0 04978 | 12 | 0 22000 | -0 01960 |
| 13 | 0 25000 | 0 03925 | 13 | 0 25000 | -0 01852 |
| 14 | 0 28000 | 0 03012 | 14 | 0 28000 | -0 01677 |
| 15 | 0 31000 | 0 02214 | 15 | 0 31000 | -0 01438 |
| 16 | 0 34000 | 0 01508 | 16 | 0 34000 | -0 01137 |
| 17 | 0 37000 | 0 00875 | 17 | 0 37000 | -0 00780 |
| 18 | 0 40000 | 0 00300 | 18 | 0 40000 | -0 00377 |
| 19 | 0 43000 | -0 00233 | 19 | 0 43000 | 0 00065 |
| 20 | 0 46000 | -0 00733 | 20 | 0 46000 | 0 00537 |
| 21 | 0 49000 | -0 01212 | 21 | 0 49000 | 0 01030 |
| 22 | 0 52000 | -0 01676 | 22 | 0 52000 | 0 01537 |
| 23 | 0 55000 | -0 02130 | 23 | 0 55000 | 0 02049 |
| 24 | 0 58000 | -0 02580 | 24 | 0 58000 | 0 02558 |
| 25 | 0 61000 | -0 03026 | 25 | 0 61000 | 0 03056 |
| 26 | 0 64000 | -0 03469 | 26 | 0 64000 | 0 03538 |
| 27 | 0 67000 | -0 03905 | 27 | 0 67000 | 0 03997 |
| 28 | 0 70000 | -0 04333 | 28 | 0 70000 | 0 04427 |
| 29 | 0 73000 | -0 04745 | 29 | 0 73000 | 0 04823 |
| 30 | 0 76000 | -0 05134 | 30 | 0 76000 | 0 05181 |
| 31 | 0 79000 | -0 05492 | 31 | 0 79000 | 0 05496 |
| 32 | 0 82000 | -0 05806 | 32 | 0 82000 | 0 05765 |
| 33 | 0 85000 | -0 06065 | 33 | 0 85000 | 0 05986 |
| 34 | 0 88000 | -0 06252 | 34 | 0 88000 | 0 06157 |
| 35 | 0 91000 | -0 06352 | 35 | 0 91000 | 0 06275 |
| 36 | 0 93500 | -0 06356 | 36 | 0 93500 | 0 06334 |
| 37 | 0 96000 | -0 06274 | 37 | 0 96000 | 0 06356 |
| 38 | 0 98000 | -0 06139 | 38 | 0 98000 | 0 06348 |
| 39 | 1 00000 | -0 05935 | 39 | 1 00000 | 0 06316 |

1AIRFOIL SURFACE SLOPES - UPPER SURFACE

| | | SPAN STATIONS/ETA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | XI | 1/ | 2/ | 3/ | 4/ | 5/ | 6/ | 7/ | 8/ | 9/ | 10/ | 11/ | 12/ | 13/ |
| INDEX | | -0 10 | 0 00 | 0 10 | 0 19 | 0 29 | 0 39 | 0 49 | 0 58 | 0 68 | 0 77 | 0 84 | 0 90 | 0 95 |
| 1 | 0 005 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 | 0 314 |
| 2 | 0 015 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 | 0 233 |
| 3 | 0 025 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 | 0 203 |
| 4 | 0 037 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 | 0 183 |
| 5 | 0 049 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 | 0 168 |
| 6 | 0 065 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 | 0 150 |
| 7 | 0 084 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 | 0 130 |
| 8 | 0 107 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 | 0 114 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | 0 132 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 | 0 093 |
| 10 | 0 161 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 | 0 076 |
| 11 | 0 190 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 |
| 12 | 0 220 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 | 0 050 |
| 13 | 0 250 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 | 0 039 |
| 14 | 0 280 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 | 0 030 |
| 15 | 0 310 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 | 0 022 |
| 16 | 0 340 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 |
| 17 | 0 370 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 | 0 009 |
| 18 | 0 400 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 |
| 19 | 0 430 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 | -0 002 |
| 20 | 0 460 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 | -0 007 |
| 21 | 0 490 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 | -0 012 |
| 22 | 0 520 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 |
| 23 | 0 550 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 | -0 021 |
| 24 | 0 580 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 | -0 026 |
| 25 | 0 610 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 | -0 030 |
| 26 | 0 640 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 | -0 035 |
| 27 | 0 670 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 | -0 039 |
| 28 | 0 700 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 | -0 043 |
| 29 | 0 730 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 | -0 047 |
| 30 | 0 760 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 | -0 051 |
| 31 | 0 790 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 | -0 055 |
| 32 | 0 820 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 | -0 058 |
| 33 | 0 850 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0.061 | -0 061 | -0 061 | -0 061 |
| 34 | 0 879 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 |
| 35 | 0 907 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 |
| 36 | 0 933 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 | -0 064 |
| 37 | 0 957 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 | -0 063 |
| 38 | 0 979 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 | -0 061 |
| 39 | 1 000 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 | -0 059 |



1AIRFOIL SURFACE SLOPES - LOWER SURFACE

| | SPAN STATIONS/ETA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | XI | 1/ | 2/ | 3/ | 4/ | 5/ | 6/ | 7/ | 8/ | 9/ | 10/ | 11/ | 12/ | 13/ |
| INDEX | | -0 10 | 0 00 | 0 10 | 0 19 | 0 29 | 0 39 | 0 49 | 0 58 | 0 68 | 0 77 | 0 84 | 0 90 | 0 95 |
| 1 | 0 005 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 | -0 277 |
| 2 | 0 015 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 | -0 120 |
| 3 | 0 025 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 | -0 075 |
| 4 | 0 037 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 | -0 054 |
| 5 | 0 049 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 | -0 042 |
| 6 | 0 065 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 | -0 031 |
| 7 | 0 084 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 | -0 025 |
| 8 | 0 107 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 | -0 022 |
| 9 | 0 132 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 |
| 10 | 0 161 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 |
| 11 | 0 190 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 |
| 12 | 0 220 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 | -0 020 |
| 13 | 0 250 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 | -0 019 |
| 14 | 0 280 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 | -0 017 |
| 15 | 0 310 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 | -0 014 |
| 16 | 0 340 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 | -0 011 |
| 17 | 0 370 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 | -0 008 |
| 18 | 0 400 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 | -0 004 |
| 19 | 0 430 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 |
| 20 | 0 460 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 |
| 21 | 0 490 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 | 0 010 |
| 22 | 0 520 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 | 0 015 |
| 23 | 0 550 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 | 0 020 |
| 24 | 0 580 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 | 0 026 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 0 610 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 | 0 031 |
| 26 | 0 640 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 | 0 035 |
| 27 | 0 670 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 | 0 040 |
| 28 | 0 700 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 | 0 044 |
| 29 | 0 730 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 | 0 048 |
| 30 | 0 760 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 | 0 052 |
| 31 | 0 790 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 | 0 055 |
| 32 | 0 820 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 | 0 058 |
| 33 | 0 850 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 | 0 060 |
| 34 | 0 879 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 | 0 062 |
| 35 | 0 907 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 |
| 36 | 0 933 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 |
| 37 | 0 957 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 | 0 064 |
| 38 | 0 979 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 |
| 39 | 1 000 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 | 0 063 |

1MOTION DESCRIPTION

MOTION TYPE MODAL

FREQUENCY = 0 55000

AMPLITUDE = 1 00000

PHASE = 0 00000

NUMBER OF TIME STEPS PER CYCLE = 1142

1DISPLACEMENTS FOR ALL GRID POINTS ON WING

| | | SPAN STATIONS/ETA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | XI | 1/ | 2/ | 3/ | 4/ | 5/ | 6/ | 7/ | 8/ | 9/ | 10/ | 11/ | 12/ | 13/ |
| INDEX | | -0 10 | 0 00 | 0 10 | 0 19 | 0 29 | 0 39 | 0 49 | 0 58 | 0 68 | 0 77 | 0 84 | 0 90 | 0 95 |
| 1 | 0 005 | -0 007 | -0 007 | -0 006 | -0 005 | -0 004 | -0 004 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 |
| 2 | 0 015 | -0 007 | -0 007 | -0 006 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 |
| 3 | 0 025 | -0 007 | -0 007 | -0 006 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 |
| 4 | 0 037 | -0 006 | -0 006 | -0 006 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 |
| 5 | 0 049 | -0 006 | -0 006 | -0 006 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 |
| 6 | 0 065 | -0 006 | -0 006 | -0 006 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 |
| 7 | 0 084 | -0 006 | -0 006 | -0 006 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 |
| 8 | 0 107 | -0 006 | -0 006 | -0 005 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 |
| 9 | 0 132 | -0 006 | -0 006 | -0 005 | -0 005 | -0 004 | -0 003 | -0 002 | -0 002 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 |
| 10 | 0 161 | -0 006 | -0 006 | -0 005 | -0 004 | -0 004 | -0 003 | -0 002 | -0 002 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 |
| 11 | 0 190 | -0 005 | -0 005 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 002 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 |
| 12 | 0 220 | -0 005 | -0 005 | -0 005 | -0 004 | -0 003 | -0 003 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 |
| 13 | 0 250 | -0 003 | -0 003 | -0 003 | -0 002 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 | 0 002 | 0 002 |
| 14 | 0 280 | -0 003 | -0 003 | -0 003 | -0 002 | -0 002 | -0 001 | -0 001 | 0 000 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 |
| 15 | 0 310 | -0 003 | -0 003 | -0 002 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 |
| 16 | 0 340 | -0 002 | -0 002 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 |
| 17 | 0 370 | -0 002 | -0 002 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 |
| 18 | 0 400 | -0 002 | -0 002 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 |
| 19 | 0 430 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 |
| 20 | 0 460 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 |
| 21 | 0 490 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 |
| 22 | 0 520 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 |
| 23 | 0 550 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 |
| 24 | 0 580 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 |
| 25 | 0 610 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 |
| 26 | 0 640 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 |
| 27 | 0 670 | 0 002 | 0 002 | 0 002 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | 0 700 | 0 002 | 0 002 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 004 |
| 29 | 0 730 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 004 | 0 004 |
| 30 | 0 760 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 004 | 0 004 | 0 004 |
| 31 | 0 790 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 004 | 0 004 | 0 004 | 0 004 |
| 32 | 0 820 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 003 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 |
| 33 | 0 850 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 |
| 34 | 0 879 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 | 0 004 |
| 35 | 0 907 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 004 |
| 36 | 0 933 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 |
| 37 | 0 957 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 |
| 38 | 0 979 | 0 006 | 0 006 | 0 006 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 |
| 39 | 1 000 | 0 006 | 0 006 | 0 006 | 0 006 | 0 006 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 | 0 005 |

1SLOPES FOR ALL GRID POINTS ON WING

| | | SPAN STATIONS/ETA | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| INDEX | XI | 1/ -0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 |
| 1 | 0 005 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 2 | 0 015 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 3 | 0 025 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 4 | 0 037 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 5 | 0 049 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 6 | 0 065 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 7 | 0 084 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 8 | 0 107 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 9 | 0 132 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 10 | 0 161 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 11 | 0 190 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 12 | 0 220 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 13 | 0 250 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 14 | 0 280 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 15 | 0 310 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 16 | 0 340 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 17 | 0 370 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0.012 | 0 012 | 0 012 | 0 012 |
| 18 | 0 400 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 19 | 0 430 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 20 | 0 460 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 21 | 0 490 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 22 | 0 520 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 23 | 0 550 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 24 | 0 580 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 25 | 0 610 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 26 | 0 640 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 27 | 0 670 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 28 | 0 700 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 29 | 0 730 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 30 | 0 760 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 31 | 0 790 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 32 | 0 820 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 33 | 0 850 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 34 | 0 879 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 35 | 0 907 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 36 | 0 933 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 37 | 0 957 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 38 | 0 979 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |
| 39 | 1 000 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 | 0 012 |

1BOUNDARY CONDITION DATA

PLANE OF SYMMETRY Y=0

DOWNSTREAM BOUNDARY CONDITION  STEADY
(FREQUENCY = LOW)

UPSTREAM BOUNDARY CONDITION  FREESTREAM

FARFIELD BOUNDARY CONDITION  FREEJET

VELOCITY AT LOWER BOUNDARY = 0 0

VELOCITY AT UPPER BOUNDARY = 0 0

JUMP CONDITION ACROSS WAKE  UNSTEADY

WIND TUNNEL WALLS  NOT USED AS BOUNDARIES

LIFTING SURFACE  UNSTEADY

ANGLES OF ATTACK

RIGID ANGLE OF ATTACK (DEG ) =  0 00000

TWIST IN DEGREES
SPAN = -0 097 0 000 0 097 0 195 0 292 0 389 0 487 0 584 0 678 0 766 0 841 0 902 0 951
TWIST = 0 000 0 000 0 000 0 000 0 000 0 000 0 000 0 000 0 000 0 000 0 000 0 000 0 000

REFERENCE AREA = 2 97680

MEAN AERODYNAMIC CHORD = 1 00000



MOMENT CENTER REFERENCE = 0 50000

REFERENCE CHORD = 1 00000

REFERENCE SPAN = 1 94680

MOMENT REFERENCE VARIABLE = 0 50000

1 PHYSICAL X GRID

| | | SPAN STATIONS/ETA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | XI | 1/ | 2/ | 3/ | 4/ | 5/ | 6/ | 7/ | 8/ | 9/ | 10/ |
| INDEX | | -0 10 | 0 00 | 0 10 | 0 19 | 0 29 | 0 39 | 0 49 | 0 58 | 0 68 | 0 77 |
| 1 | -15 375 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 |
| 2 | -8 108 | -8 012 | -7 929 | -7 842 | -7 751 | -7 655 | -7 554 | -7 445 | -7 328 | -7 205 | -7 079 |
| 3 | -4 247 | -4 264 | -4 163 | -4 059 | -3 951 | -3 839 | -3 721 | -3 596 | -3 465 | -3 329 | -3 192 |
| 4 | -2 205 | -2 262 | -2 166 | -2 068 | -1 967 | -1 863 | -1 755 | -1 643 | -1 527 | -1 408 | -1 291 |
| 5 | -1 132 | -1 201 | -1 115 | -1 027 | -0 937 | -0 846 | -0 753 | -0 657 | -0 559 | -0 460 | -0 365 |
| 6 | -0 574 | -0 644 | -0 566 | -0 488 | -0 408 | -0 328 | -0 247 | -0 164 | -0 081 | 0 002 | 0 081 |
| 7 | -0 288 | -0 357 | -0 285 | -0 213 | -0 141 | -0 068 | 0 005 | 0 078 | 0 152 | 0 225 | 0 294 |
| 8 | -0 145 | -0 212 | -0 144 | -0 077 | -0 009 | 0 059 | 0 127 | 0 195 | 0 263 | 0 330 | 0 393 |
| 9 | -0 076 | -0 140 | -0 075 | -0 011 | 0 054 | 0 119 | 0 185 | 0 250 | 0 315 | 0 378 | 0 437 |
| 10 | -0 043 | -0 106 | -0 043 | 0 021 | 0 084 | 0 148 | 0 211 | 0 274 | 0 338 | 0 399 | 0 456 |
| 11 | -0 026 | -0 088 | -0 026 | 0 036 | 0 099 | 0 161 | 0 224 | 0 286 | 0 348 | 0 409 | 0 465 |
| 12 | -0 015 | -0 077 | -0 015 | 0 047 | 0 108 | 0 170 | 0 232 | 0 293 | 0 355 | 0 414 | 0 470 |
| 13 | -0 005 | -0 066 | -0 005 | 0 056 | 0 117 | 0 178 | 0 239 | 0 300 | 0 361 | 0 420 | 0 475 |
| 14 | 0 005 | -0 055 | 0 005 | 0 065 | 0 126 | 0 186 | 0 246 | 0 306 | 0 366 | 0 425 | 0 479 |
| 15 | 0 015 | -0 045 | 0 015 | 0 075 | 0 134 | 0 194 | 0 253 | 0 313 | 0 372 | 0 430 | 0 484 |
| 16 | 0 025 | -0 033 | 0 025 | 0 084 | 0 143 | 0 202 | 0 261 | 0 320 | 0 378 | 0 435 | 0 489 |
| 17 | 0 037 | -0 022 | 0 037 | 0 095 | 0 153 | 0 211 | 0 269 | 0 327 | 0 385 | 0 441 | 0 494 |
| 18 | 0 049 | -0 008 | 0 049 | 0 107 | 0 164 | 0 221 | 0 278 | 0 335 | 0 392 | 0 448 | 0 500 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19 | 0 065 | 0 009 | 0 065 | 0 121 | 0 177 | 0 233 | 0 289 | 0 346 | 0 401 | 0 456 | 0 507 | | |
| 20 | 0 084 | 0 029 | 0 084 | 0 139 | 0 194 | 0 248 | 0 303 | 0 358 | 0 413 | 0 466 | 0 515 | | |
| 21 | 0 107 | 0 053 | 0 107 | 0 160 | 0 213 | 0 266 | 0 320 | 0 373 | 0 426 | 0 477 | 0 526 | | |
| 22 | 0 132 | 0 081 | 0 132 | 0 184 | 0 235 | 0 287 | 0 338 | 0 390 | 0 441 | 0 491 | 0 537 | | |
| 23 | 0 161 | 0 111 | 0 161 | 0 210 | 0 260 | 0 309 | 0 359 | 0 408 | 0 457 | 0 506 | 0 550 | | |
| 24 | 0 190 | 0 143 | 0 190 | 0 238 | 0 285 | 0 333 | 0 380 | 0 427 | 0 475 | 0 521 | 0 564 | | |
| 25 | 0 220 | 0 175 | 0 220 | 0 265 | 0 311 | 0 356 | 0 402 | 0 447 | 0 492 | 0 536 | 0 577 | | |
| 26 | 0 250 | 0 207 | 0 250 | 0 293 | 0 337 | 0 380 | 0 423 | 0 467 | 0 510 | 0 552 | 0 591 | | |
| 27 | 0 280 | 0 239 | 0 280 | 0 321 | 0 363 | 0 404 | 0 445 | 0 486 | 0 527 | 0 567 | 0 605 | | |
| 28 | 0 310 | 0 271 | 0 310 | 0 349 | 0 388 | 0 428 | 0 467 | 0 506 | 0 545 | 0 583 | 0 618 | | |
| 29 | 0 340 | 0 303 | 0 340 | 0 377 | 0 414 | 0 451 | 0 488 | 0 526 | 0 562 | 0 598 | 0 632 | | |
| 30 | 0 370 | 0 335 | 0 370 | 0 405 | 0 440 | 0 475 | 0 510 | 0 545 | 0 580 | 0 614 | 0 646 | | |
| 31 | 0 400 | 0 367 | 0 400 | 0 433 | 0 466 | 0 499 | 0 532 | 0 565 | 0 598 | 0 630 | 0 659 | | |
| 32 | 0 430 | 0 399 | 0 430 | 0 461 | 0 492 | 0 523 | 0 554 | 0 584 | 0 615 | 0 645 | 0 673 | | |
| 33 | 0 460 | 0 431 | 0 460 | 0 489 | 0 518 | 0 546 | 0 575 | 0 604 | 0 633 | 0 661 | 0 687 | | |
| 34 | 0 490 | 0 463 | 0 490 | 0 517 | 0 543 | 0 570 | 0 597 | 0 624 | 0 650 | 0 676 | 0 700 | | |
| 35 | 0 520 | 0 495 | 0 520 | 0 545 | 0 569 | 0 594 | 0 619 | 0 643 | 0 668 | 0 692 | 0 714 | | |
| 36 | 0 550 | 0 527 | 0 550 | 0 573 | 0 595 | 0 618 | 0 640 | 0 663 | 0 685 | 0 707 | 0 728 | | |
| 37 | 0 580 | 0 560 | 0 580 | 0 600 | 0 621 | 0 641 | 0 662 | 0 682 | 0 703 | 0 723 | 0 741 | | |
| 38 | 0 610 | 0 592 | 0 610 | 0 628 | 0 647 | 0 665 | 0 684 | 0 702 | 0 720 | 0 738 | 0 755 | | |
| 39 | 0 640 | 0 624 | 0 640 | 0 656 | 0 673 | 0 689 | 0 705 | 0 722 | 0 738 | 0 754 | 0 769 | | |
| 40 | 0 670 | 0 656 | 0 670 | 0 684 | 0 699 | 0 713 | 0 727 | 0 741 | 0 756 | 0 769 | 0 782 | | |

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| | | SPAN STATIONS/ETA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| INDEX | XI | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 | 14/ 0 99 | 15/ 1 04 | 16/ 1 10 | 17/ 1 20 | 18/ 1 37 | 19/ 1 62 | 20/ 1 95 |
| 1 | -15 375 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 | -15 000 |
| 2 | -8 108 | -6 960 | -6 855 | -6 764 | -6 685 | -6 613 | -6 542 | -6 496 | -6 473 | -6 437 | -6 391 |
| 3 | -4 247 | -3 065 | -2 956 | -2 862 | -2 782 | -2 709 | -2 636 | -2 585 | -2 552 | -2 501 | -2 437 |
| 4 | -2 205 | -1 184 | -1 094 | -1 018 | -0 954 | -0 895 | -0 836 | -0 790 | -0 753 | -0 695 | -0 623 |
| 5 | -1 132 | -0 280 | -0 209 | -0 151 | -0 101 | -0 056 | -0 009 | 0 030 | 0 070 | 0 129 | 0 205 |
| 6 | -0 574 | 0 151 | 0 208 | 0 254 | 0 294 | 0 329 | 0 367 | 0 403 | 0 443 | 0 504 | 0 580 |
| 7 | -0 288 | 0 353 | 0 402 | 0 441 | 0 474 | 0 504 | 0 537 | 0 570 | 0 610 | 0 671 | 0 748 |
| 8 | -0 145 | 0 447 | 0 490 | 0 525 | 0 554 | 0 581 | 0 611 | 0 643 | 0 683 | 0 745 | 0 822 |
| 9 | -0 076 | 0 488 | 0 529 | 0 562 | 0 589 | 0 615 | 0 643 | 0 674 | 0 714 | 0 776 | 0 853 |
| 10 | -0 043 | 0 506 | 0 545 | 0 577 | 0 604 | 0 628 | 0 656 | 0 687 | 0 727 | 0 788 | 0 866 |
| 11 | -0 026 | 0 514 | 0 553 | 0 584 | 0 610 | 0 634 | 0 661 | 0 692 | 0 732 | 0 794 | 0 871 |
| 12 | -0 015 | 0 518 | 0 557 | 0 587 | 0 613 | 0 637 | 0 664 | 0 695 | 0 735 | 0 796 | 0 874 |
| 13 | -0 005 | 0 522 | 0 560 | 0 591 | 0 616 | 0 640 | 0 667 | 0 697 | 0 737 | 0 799 | 0 876 |
| 14 | 0 005 | 0 526 | 0 564 | 0 594 | 0 619 | 0 643 | 0 669 | 0 700 | 0 740 | 0 801 | 0 878 |
| 15 | 0 015 | 0 530 | 0 567 | 0 597 | 0 622 | 0 645 | 0 672 | 0 702 | 0 742 | 0 804 | 0 881 |
| 16 | 0 025 | 0 534 | 0 571 | 0 600 | 0 625 | 0 648 | 0 674 | 0 705 | 0 745 | 0 806 | 0 883 |
| 17 | 0 037 | 0 539 | 0 575 | 0 604 | 0 628 | 0 651 | 0 677 | 0 707 | 0 748 | 0 809 | 0 886 |
| 18 | 0 049 | 0 544 | 0 580 | 0 608 | 0 632 | 0 655 | 0 680 | 0 710 | 0 751 | 0 812 | 0 889 |
| 19 | 0 065 | 0 550 | 0 585 | 0 613 | 0 637 | 0 659 | 0 684 | 0 714 | 0 754 | 0 816 | 0 893 |
| 20 | 0 084 | 0 558 | 0 592 | 0 619 | 0 642 | 0 664 | 0 689 | 0 719 | 0 759 | 0 820 | 0 898 |
| 21 | 0 107 | 0 567 | 0 600 | 0 627 | 0 649 | 0 670 | 0 695 | 0 724 | 0 765 | 0 826 | 0 903 |
| 22 | 0 132 | 0 577 | 0 609 | 0 635 | 0 657 | 0 677 | 0 701 | 0 731 | 0 771 | 0 832 | 0 909 |
| 23 | 0 161 | 0 589 | 0 620 | 0 644 | 0 665 | 0 685 | 0 708 | 0 738 | 0 778 | 0 839 | 0 916 |
| 24 | 0 190 | 0 601 | 0 630 | 0 654 | 0 674 | 0 693 | 0 716 | 0 745 | 0 785 | 0 846 | 0 923 |
| 25 | 0 220 | 0 613 | 0 641 | 0 664 | 0 683 | 0 701 | 0 723 | 0 752 | 0 792 | 0 854 | 0 931 |
| 26 | 0 250 | 0 625 | 0 652 | 0 673 | 0 692 | 0 710 | 0 731 | 0 759 | 0 799 | 0 861 | 0 938 |
| 27 | 0 280 | 0 637 | 0 662 | 0 683 | 0 701 | 0 718 | 0 739 | 0 767 | 0 807 | 0 868 | 0 945 |
| 28 | 0 310 | 0 649 | 0 673 | 0 693 | 0 709 | 0 726 | 0 746 | 0 774 | 0 814 | 0 875 | 0 953 |
| 29 | 0 340 | 0 661 | 0 684 | 0 702 | 0 718 | 0 734 | 0 754 | 0 781 | 0 821 | 0 883 | 0 960 |
| 30 | 0 370 | 0 673 | 0 695 | 0 712 | 0 727 | 0 742 | 0 761 | 0 788 | 0 829 | 0 890 | 0 967 |
| 31 | 0 400 | 0 685 | 0 705 | 0 722 | 0 736 | 0 751 | 0 769 | 0 796 | 0 836 | 0 897 | 0 974 |
| 32 | 0 430 | 0 697 | 0 716 | 0 732 | 0 745 | 0 759 | 0 777 | 0 803 | 0 843 | 0 905 | 0 982 |
| 33 | 0 460 | 0 709 | 0 727 | 0 741 | 0 754 | 0 767 | 0 784 | 0 810 | 0 850 | 0 912 | 0 989 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 0 490 | 0 721 | 0 738 | 0 751 | 0 763 | 0 775 | 0 792 | 0 818 | 0 858 | 0 919 | 0 996 |
| 35 | 0 520 | 0 733 | 0 748 | 0 761 | 0 772 | 0 783 | 0 799 | 0 825 | 0 865 | 0 926 | 1 004 |
| 36 | 0 550 | 0 745 | 0 759 | 0 770 | 0 781 | 0 792 | 0 807 | 0 832 | 0 872 | 0 934 | 1 011 |
| 37 | 0 580 | 0 757 | 0 770 | 0 780 | 0 789 | 0 800 | 0 814 | 0 839 | 0 880 | 0 941 | 1 018 |
| 38 | 0 610 | 0 769 | 0 781 | 0 790 | 0 798 | 0 808 | 0 822 | 0 847 | 0 887 | 0 948 | 1 026 |
| 39 | 0 640 | 0 781 | 0 791 | 0 800 | 0 807 | 0 816 | 0 830 | 0 854 | 0 894 | 0 956 | 1 033 |
| 40 | 0 670 | 0 793 | 0 802 | 0 809 | 0 816 | 0 824 | 0 837 | 0 861 | 0 901 | 0 963 | 1 040 |

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| INDEX | XI | 1/ −0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 0 700 | 0 688 | 0 700 | 0 712 | 0 724 | 0 737 | 0 749 | 0 761 | 0 773 | 0 785 | 0 796 |
| 42 | 0 730 | 0 720 | 0 730 | 0 740 | 0 750 | 0 760 | 0 770 | 0 781 | 0 791 | 0 800 | 0 810 |
| 43 | 0 760 | 0 752 | 0 760 | 0 768 | 0 776 | 0 784 | 0 792 | 0 800 | 0 808 | 0 816 | 0 823 |
| 44 | 0 790 | 0 784 | 0 790 | 0 796 | 0 802 | 0 808 | 0 814 | 0 820 | 0 826 | 0 832 | 0 837 |
| 45 | 0 820 | 0 816 | 0 820 | 0 824 | 0 828 | 0 832 | 0 836 | 0 839 | 0 843 | 0 847 | 0 851 |
| 46 | 0 850 | 0 848 | 0 850 | 0 851 | 0 853 | 0 855 | 0 857 | 0 859 | 0 861 | 0 862 | 0 864 |
| 47 | 0 879 | 0 879 | 0 879 | 0 879 | 0 878 | 0 878 | 0 878 | 0 878 | 0 878 | 0 877 | 0 877 |
| 48 | 0 907 | 0 909 | 0 907 | 0 904 | 0 902 | 0 900 | 0 898 | 0 896 | 0 894 | 0 892 | 0 890 |
| 49 | 0 933 | 0 937 | 0 933 | 0 929 | 0 925 | 0 921 | 0 917 | 0 913 | 0 909 | 0 905 | 0 902 |
| 50 | 0 957 | 0 962 | 0 957 | 0 951 | 0 945 | 0 940 | 0 934 | 0 929 | 0 923 | 0 918 | 0 913 |
| 51 | 0 979 | 0 986 | 0 979 | 0 972 | 0 965 | 0 958 | 0 950 | 0 943 | 0 936 | 0 929 | 0 923 |
| 52 | 1 000 | 1 009 | 1 000 | 0 991 | 0 983 | 0 974 | 0 966 | 0 957 | 0 949 | 0 940 | 0 933 |
| 53 | 1 022 | 1 032 | 1 022 | 1 012 | 1 002 | 0 992 | 0 982 | 0 971 | 0 961 | 0 952 | 0 943 |
| 54 | 1 052 | 1 064 | 1 052 | 1 039 | 1 027 | 1 015 | 1 003 | 0 991 | 0 979 | 0 967 | 0 956 |
| 55 | 1 104 | 1 102 | 1 087 | 1 073 | 1 058 | 1 044 | 1 029 | 1 015 | 1 000 | 0 986 | 0 973 |
| 56 | 1 204 | 1 166 | 1 148 | 1 130 | 1 112 | 1 094 | 1 075 | 1 057 | 1 039 | 1 021 | 1 004 |
| 57 | 1 395 | 1 289 | 1 265 | 1 241 | 1 217 | 1 193 | 1 168 | 1 144 | 1 119 | 1 094 | 1 071 |
| 58 | 1 752 | 1 529 | 1 496 | 1 463 | 1 429 | 1 395 | 1 361 | 1 325 | 1 289 | 1 254 | 1 219 |
| 59 | 2 405 | 1 995 | 1 949 | 1 902 | 1 854 | 1 804 | 1 753 | 1 701 | 1 647 | 1 592 | 1 539 |
| 60 | 3 575 | 2 892 | 2 827 | 2 759 | 2 690 | 2 618 | 2 542 | 2 464 | 2 382 | 2 298 | 2 215 |
| 61 | 5 646 | 4 595 | 4 506 | 4 414 | 4 317 | 4 216 | 4 110 | 3 997 | 3 878 | 3 753 | 3 628 |
| 62 | 9 276 | 7 802 | 7 693 | 7 579 | 7 458 | 7 330 | 7 194 | 7 048 | 6 892 | 6 726 | 6 557 |
| 63 | 15 601 | 13 805 | 13 704 | 13 597 | 13 483 | 13 361 | 13 230 | 13 088 | 12 933 | 12 766 | 12 594 |
| 64 | 26 575 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | 0 700 | 0 805 | 0 813 | 0 819 | 0 825 | 0 833 | 0 845 | 0 869 | 0 909 | 0 970 | 1 047 |
| 42 | 0 730 | 0 817 | 0 824 | 0 829 | 0 834 | 0 841 | 0 852 | 0 876 | 0 916 | 0 977 | 1 055 |
| 43 | 0 760 | 0 829 | 0 834 | 0 839 | 0 843 | 0 849 | 0 860 | 0 883 | 0 923 | 0 985 | 1 062 |
| 44 | 0 790 | 0 842 | 0 845 | 0 848 | 0 852 | 0 857 | 0 867 | 0 890 | 0 931 | 0 992 | 1 069 |
| 45 | 0 820 | 0 854 | 0 856 | 0 858 | 0 861 | 0 865 | 0 875 | 0 898 | 0 938 | 0 999 | 1 077 |
| 46 | 0 850 | 0 866 | 0 867 | 0 868 | 0 869 | 0 874 | 0 883 | 0 905 | 0 945 | 1 007 | 1 084 |
| 47 | 0 879 | 0 877 | 0 877 | 0 877 | 0 878 | 0 881 | 0 890 | 0 912 | 0 952 | 1 014 | 1 091 |
| 48 | 0 907 | 0 888 | 0 887 | 0 886 | 0 886 | 0 889 | 0 897 | 0 919 | 0 959 | 1 020 | 1 098 |
| 49 | 0 933 | 0 899 | 0 896 | 0 894 | 0 894 | 0 896 | 0 904 | 0 925 | 0 965 | 1 027 | 1 104 |
| 50 | 0 957 | 0 908 | 0 905 | 0 902 | 0 901 | 0 903 | 0 910 | 0 931 | 0 971 | 1 033 | 1 110 |
| 51 | 0 979 | 0 917 | 0 913 | 0 909 | 0 908 | 0 909 | 0 915 | 0 936 | 0 977 | 1 038 | 1 115 |
| 52 | 1 000 | 0 926 | 0 921 | 0 916 | 0 914 | 0 915 | 0 921 | 0 942 | 0 982 | 1 043 | 1 120 |
| 53 | 1 022 | 0 935 | 0 928 | 0 923 | 0 920 | 0 921 | 0 926 | 0 947 | 0 987 | 1 048 | 1 126 |
| 54 | 1 052 | 0 947 | 0 939 | 0 933 | 0 929 | 0 929 | 0 934 | 0 954 | 0 994 | 1 056 | 1 133 |
| 55 | 1 104 | 0 961 | 0 952 | 0 945 | 0 940 | 0 939 | 0 943 | 0 963 | 1 003 | 1 065 | 1 142 |
| 56 | 1 204 | 0 990 | 0 978 | 0 968 | 0 962 | 0 959 | 0 962 | 0 982 | 1 022 | 1 083 | 1 160 |
| 57 | 1 395 | 1 051 | 1 035 | 1 022 | 1 012 | 1 007 | 1 007 | 1 025 | 1 065 | 1 127 | 1 204 |
| 58 | 1 752 | 1 189 | 1 164 | 1 144 | 1 128 | 1 117 | 1 113 | 1 129 | 1 169 | 1 230 | 1 307 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59 | 2 405 | 1 491 | 1 451 | 1 417 | 1.391 | 1 370 | 1 357 | 1 368 | 1 408 | 1.469 | 1 546 | |
| 60 | 3 575 | 2 139 | 2 074 | 2 019 | 1 974 | 1 938 | 1 909 | 1 913 | 1 952 | 2 012 | 2 087 | |
| 61 | 5 646 | 3 512 | 3 411 | 3 325 | 3 253 | 3 192 | 3 139 | 3 130 | 3 168 | 3 226 | 3 298 | |
| 62 | 9 276 | 6 397 | 6 257 | 6 135 | 6 031 | 5 941 | 5 859 | 5 835 | 5 869 | 5 921 | 5 986 | |
| 63 | 15 601 | 12 428 | 12 281 | 12 151 | 12 039 | 11 940 | 11 848 | 11 814 | 11 838 | 11 875 | 11 921 | |
| 64 | 26 575 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | 25 000 | |

PLAN FORM COMPUTED FROM GDPLAN

| SPAN STATION | ETA | XLE | XTE | CHORD |
|---|---|---|---|---|
| 1 | -0 0973 | -0 0606 | 1 0086 | 1 0692 |
| 2 | 0 0000 | 0 0000 | 1 0000 | 1 0000 |
| 3 | 0 0973 | 0 0606 | 0 9914 | 0 9308 |
| 4 | 0 1947 | 0 1213 | 0 9829 | 0 8616 |
| 5 | 0 2920 | 0 1819 | 0 9743 | 0 7924 |
| 6 | 0 3894 | 0 2425 | 0 9657 | 0 7232 |
| 7 | 0 4867 | 0 3031 | 0 9571 | 0 6540 |
| 8 | 0 5835 | 0 3634 | 0 9486 | 0 5852 |
| 9 | 0 6780 | 0 4223 | 0 9403 | 0 5180 |
| 10 | 0 7659 | 0 4770 | 0 9326 | 0 4555 |
| 11 | 0 8415 | 0 5241 | 0 9259 | 0 4018 |
| 12 | 0 9022 | 0 5619 | 0 9206 | 0 3586 |
| 13 | 0 9508 | 0 5922 | 0 9163 | 0 3241 |
| 14 | 0 9938 | 0 6176 | 0 9139 | 0 2964 |
| 15 | 1 0394 | 0 6413 | 0 9146 | 0 2733 |
| 16 | 1 1002 | 0 6679 | 0 9205 | 0 2527 |
| 17 | 1 1988 | 0 6985 | 0 9415 | 0 2431 |
| 18 | 1 3669 | 0 7386 | 0 9817 | 0 2431 |
| 19 | 1 6238 | 0 8001 | 1 0431 | 0 2431 |
| 20 | 1 9468 | 0 8773 | 1 1203 | 0 2431 |

TOTAL AREA IN USERS UNITS = 0 62632

********** Note  Results for cycle 1 and 2 are skipped **********

CYCLE =  3

OURIER COEFFICIENTS FOR UPPER SURFACE PRESSURES  CONSTANT TERM (A0)

| INDEX | XI | SPAN STATIONS/ETA 1/ -0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 005 | 2 838 | 0 717 | 0 541 | 0 522 | 0 514 | 0 505 | 0 494 | 0 481 | 0 467 | 0 450 | 0 430 | 0 404 | 0 324 |
| 2 | 0 015 | 2 492 | 0 534 | 0 393 | 0 374 | 0 364 | 0 356 | 0 348 | 0 339 | 0 329 | 0 317 | 0 303 | 0 279 | 0 192 |
| 3 | 0 025 | 1 881 | 0 382 | 0 274 | 0 252 | 0 241 | 0 233 | 0 226 | 0 218 | 0 211 | 0 203 | 0 193 | 0 169 | 0 076 |
| 4 | 0 037 | 1 153 | 0 280 | 0 196 | 0 171 | 0 158 | 0 148 | 0 140 | 0 132 | 0 125 | 0 117 | 0 107 | 0 081 | -0 016 |
| 5 | 0 049 | 0 728 | 0 204 | 0 130 | 0 104 | 0 088 | 0 077 | 0 067 | 0 058 | 0 050 | 0 042 | 0 031 | 0 000 | -0 098 |
| 6 | 0 065 | 0 495 | 0 137 | 0 070 | 0 042 | 0 025 | 0 012 | 0 001 | -0 009 | -0 018 | -0 028 | -0 041 | -0 078 | -0 172 |
| 7 | 0 084 | 0 314 | 0 081 | 0 019 | -0 010 | -0 029 | -0 044 | -0 056 | -0 067 | -0 077 | -0 089 | -0 106 | -0 149 | -0 232 |
| 8 | 0 107 | 0 196 | 0 029 | -0 029 | -0 059 | -0 080 | -0 096 | -0 109 | -0 121 | -0 133 | -0 146 | -0 169 | -0 217 | -0 278 |
| 9 | 0 132 | 0 110 | -0 019 | -0 071 | -0 102 | -0 123 | -0 140 | -0 154 | -0 167 | -0 180 | -0 196 | -0 223 | -0 272 | -0 309 |
| 10 | 0 161 | 0 026 | -0 056 | -0 101 | -0 131 | -0 152 | -0 170 | -0 185 | -0 199 | -0 214 | -0 232 | -0 263 | -0 307 | -0 321 |
| 11 | 0 190 | -0 029 | -0 086 | -0 126 | -0 154 | -0 175 | -0 193 | -0 209 | -0 223 | -0 239 | -0 260 | -0 292 | -0 330 | -0 322 |
| 12 | 0 220 | -0 068 | -0 111 | -0 146 | -0 172 | -0 193 | -0 211 | -0 226 | -0 241 | -0 258 | -0 281 | -0 315 | -0 343 | -0 314 |
| 13 | 0 250 | -0 100 | -0 132 | -0 163 | -0 187 | -0 207 | -0 224 | -0 240 | -0 255 | -0 273 | -0 298 | -0 331 | -0 347 | -0 301 |
| 14 | 0 280 | -0 126 | -0 150 | -0 177 | -0 199 | -0 218 | -0 235 | -0 250 | -0 266 | -0 285 | -0 312 | -0 341 | -0 343 | -0 283 |
| 15 | 0 310 | -0 147 | -0 166 | -0 189 | -0 209 | -0 227 | -0 243 | -0 258 | -0 274 | -0 295 | -0 322 | -0 345 | -0 331 | -0 263 |
| 16 | 0 340 | -0 165 | -0 179 | -0 199 | -0 218 | -0 234 | -0 249 | -0 264 | -0 281 | -0 302 | -0 328 | -0 342 | -0 313 | -0 241 |
| 17 | 0 370 | -0 180 | -0 191 | -0 208 | -0 225 | -0 240 | -0 255 | -0 270 | -0 287 | -0 308 | -0 330 | -0 333 | -0 289 | -0 220 |
| 18 | 0 400 | -0 192 | -0 202 | -0 217 | -0 231 | -0 246 | -0 259 | -0 274 | -0 291 | -0 311 | -0 328 | -0 317 | -0 262 | -0 200 |
| 19 | 0 430 | -0 204 | -0 211 | -0 224 | -0 237 | -0 250 | -0 263 | -0 277 | -0 294 | -0 312 | -0 321 | -0 294 | -0 234 | -0 182 |
| 20 | 0 460 | -0 213 | -0 220 | -0 231 | -0 243 | -0 254 | -0 266 | -0 280 | -0 295 | -0 310 | -0 308 | -0 266 | -0 208 | -0 169 |
| 21 | 0 490 | -0 222 | -0 227 | -0 237 | -0 247 | -0 257 | -0 268 | -0 281 | -0 294 | -0 303 | -0 287 | -0 233 | -0 187 | -0 158 |
| 22 | 0 520 | -0 230 | -0 234 | -0 241 | -0 250 | -0 259 | -0 269 | -0 280 | -0 290 | -0 290 | -0 257 | -0 201 | -0 172 | -0 149 |
| 23 | 0 550 | -0 236 | -0 238 | -0 244 | -0 251 | -0 259 | -0 267 | -0 275 | -0 280 | -0 265 | -0 216 | -0 177 | -0 162 | -0 142 |
| 24 | 0 580 | -0 241 | -0 241 | -0 245 | -0 249 | -0 255 | -0 261 | -0 264 | -0 258 | -0 225 | -0 178 | -0 163 | -0 154 | -0 134 |
| 25 | 0 610 | -0 242 | -0 240 | -0 241 | -0 243 | -0 245 | -0 245 | -0 239 | -0 216 | -0 176 | -0 156 | -0 154 | -0 145 | -0 125 |
| 26 | 0 640 | -0 238 | -0 232 | -0 229 | -0 226 | -0 221 | -0 212 | -0 192 | -0 164 | -0 145 | -0 146 | -0 144 | -0 134 | -0.115 |
| 27 | 0 670 | -0 222 | -0 211 | -0 201 | -0 190 | -0 178 | -0 162 | -0 144 | -0 133 | -0 134 | -0 135 | -0 131 | -0 122 | -0 104 |
| 28 | 0 700 | -0 190 | -0 172 | -0 157 | -0 145 | -0 134 | -0 124 | -0 119 | -0 119 | -0 120 | -0 119 | -0 115 | -0 107 | -0 092 |
| 29 | 0 730 | -0 150 | -0 131 | -0 119 | -0 112 | -0 107 | -0 104 | -0 102 | -0 101 | -0 100 | -0 099 | -0 097 | -0 091 | -0 079 |
| 30 | 0 760 | -0 111 | -0 099 | -0 092 | -0 088 | -0 084 | -0 082 | -0 080 | -0 078 | -0 078 | -0 077 | -0 076 | -0 073 | -0 064 |
| 31 | 0 790 | -0 078 | -0 069 | -0 064 | -0 061 | -0 058 | -0 056 | -0 054 | -0 053 | -0 052 | -0 052 | -0 053 | -0 052 | -0 047 |
| 32 | 0 820 | -0 044 | -0 038 | -0 034 | -0 031 | -0 029 | -0 027 | -0 026 | -0 025 | -0 024 | -0 025 | -0 027 | -0 029 | -0 029 |
| 33 | 0 850 | -0 008 | -0 004 | -0 002 | 0 000 | 0 002 | 0 004 | 0 005 | 0 006 | 0 006 | 0 004 | 0 001 | -0 004 | -0 008 |
| 34 | 0 879 | 0 030 | 0 031 | 0 032 | 0 033 | 0 035 | 0 036 | 0 037 | 0 038 | 0 038 | 0 036 | 0 032 | 0 024 | 0 014 |
| 35 | 0 907 | 0 069 | 0 066 | 0 066 | 0 067 | 0 068 | 0 070 | 0 071 | 0 071 | 0 071 | 0 069 | 0 064 | 0 055 | 0 039 |
| 36 | 0 933 | 0 109 | 0 102 | 0 101 | 0 102 | 0 103 | 0 104 | 0 105 | 0 106 | 0 105 | 0 103 | 0 098 | 0 088 | 0 067 |
| 37 | 0 957 | 0 153 | 0 140 | 0 138 | 0 139 | 0 140 | 0 141 | 0 142 | 0 142 | 0 142 | 0 140 | 0 135 | 0 124 | 0 099 |
| 38 | 0 979 | 0 208 | 0 185 | 0 182 | 0 183 | 0 184 | 0 186 | 0 186 | 0 187 | 0 187 | 0 185 | 0 180 | 0 168 | 0 141 |
| 39 | 1 000 | 0 315 | 0 263 | 0 260 | 0 260 | 0 261 | 0 261 | 0 261 | 0 260 | 0 258 | 0 255 | 0 248 | 0 236 | 0 208 |

FOURIER COEFFICIENTS FOR UPPER SURFACE PRESSURES  A1 TERM

CYCLE =  3

| INDEX | XI | SPAN STATIONS/ETA 1/ -0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 005 | -0 030 | -0 021 | -0 026 | -0 031 | -0 035 | -0 038 | -0 041 | -0 044 | -0 046 | -0 048 | -0 049 | -0 049 | -0 045 |
| 2 | 0 015 | -0 042 | -0 018 | -0 022 | -0 027 | -0 030 | -0 033 | -0 036 | -0 039 | -0 042 | -0 044 | -0 046 | -0 046 | -0 042 |
| 3 | 0 025 | -0 043 | -0 016 | -0 019 | -0 023 | -0 026 | -0 029 | -0 032 | -0 035 | -0 038 | -0 041 | -0 042 | -0 043 | -0 039 |
| 4 | 0 037 | -0 033 | -0 014 | -0 017 | -0 020 | -0 023 | -0 026 | -0 028 | -0 031 | -0 035 | -0 037 | -0 039 | -0 040 | -0 035 |
| 5 | 0 049 | -0 025 | -0 013 | -0 015 | -0 018 | -0 020 | -0 023 | -0 026 | -0 029 | -0 032 | -0 034 | -0 036 | -0 037 | -0 033 |
| 6 | 0 065 | -0 020 | -0 012 | -0 013 | -0 016 | -0 018 | -0 021 | -0 023 | -0 026 | -0 029 | -0 032 | -0 034 | -0 035 | -0 030 |
| 7 | 0 084 | -0 016 | -0 011 | -0 012 | -0 014 | -0 016 | -0 019 | -0 021 | -0 024 | -0 027 | -0 030 | -0 032 | -0 033 | -0 026 |
| 8 | 0 107 | -0 014 | -0 010 | -0 011 | -0 013 | -0 015 | -0 017 | -0 020 | -0 023 | -0 026 | -0 029 | -0 031 | -0 031 | -0 023 |
| 9 | 0 132 | -0 012 | -0 010 | -0 010 | -0 012 | -0 014 | -0 016 | -0 019 | -0 022 | -0 025 | -0 028 | -0 029 | -0 027 | -0 021 |
| 10 | 0 161 | -0 011 | -0 009 | -0 009 | -0 010 | -0 012 | -0 015 | -0 018 | -0 021 | -0 024 | -0 026 | -0 027 | -0 025 | -0 019 |
| 11 | 0 190 | -0 010 | -0 008 | -0 008 | -0 009 | -0 011 | -0 014 | -0 016 | -0 019 | -0 022 | -0 024 | -0 025 | -0 024 | -0 017 |
| 12 | 0 220 | -0 011 | -0 007 | -0 006 | -0 008 | -0 010 | -0 012 | -0 015 | -0 018 | -0 020 | -0 022 | -0 024 | -0 022 | -0 014 |
| 13 | 0 250 | -0 009 | -0 006 | -0 006 | -0 007 | -0 009 | -0 012 | -0 014 | -0 017 | -0 020 | -0 022 | -0 023 | -0 020 | -0 011 |
| 14 | 0 280 | -0 006 | -0 006 | -0 007 | -0 008 | -0 010 | -0 013 | -0 015 | -0 018 | -0 021 | -0 023 | -0 024 | -0 019 | -0 008 |
| 15 | 0 310 | -0 006 | -0 006 | -0 007 | -0 009 | -0 011 | -0 014 | -0 016 | -0 019 | -0 022 | -0 024 | -0 024 | -0 016 | -0 002 |
| 16 | 0 340 | -0 007 | -0 007 | -0 008 | -0 010 | -0 012 | -0 015 | -0 018 | -0 021 | -0 023 | -0 025 | -0 023 | -0 010 | 0 005 |
| 17 | 0 370 | -0 007 | -0 008 | -0 009 | -0 011 | -0 014 | -0 016 | -0 019 | -0 022 | -0 025 | -0 026 | -0 019 | 0 001 | 0 014 |
| 18 | 0 400 | -0 008 | -0 009 | -0 010 | -0 013 | -0 015 | -0 019 | -0 021 | -0 024 | -0 026 | -0 024 | -0 009 | 0 016 | 0 021 |
| 19 | 0 430 | -0 009 | -0 010 | -0 012 | -0 015 | -0 018 | -0 021 | -0 024 | -0 025 | -0 025 | -0 017 | 0 008 | 0 030 | 0 023 |
| 20 | 0 460 | -0 011 | -0 012 | -0 015 | -0 018 | -0 021 | -0 023 | -0 025 | -0 025 | -0 020 | -0 002 | 0 031 | 0 039 | 0 022 |
| 21 | 0 490 | -0 013 | -0 015 | -0 018 | -0 021 | -0 023 | -0 024 | -0 024 | -0 020 | -0 008 | 0 022 | 0 050 | 0 038 | 0 019 |
| 22 | 0 520 | -0 016 | -0 018 | -0 021 | -0 023 | -0 024 | -0 022 | -0 018 | -0 008 | 0 015 | 0 051 | 0 055 | 0 031 | 0 016 |
| 23 | 0 550 | -0 018 | -0 021 | -0 022 | -0 022 | -0 020 | -0 014 | -0 004 | 0 015 | 0 047 | 0 069 | 0 044 | 0 024 | 0 013 |
| 24 | 0 580 | -0 020 | -0 020 | -0 019 | -0 015 | -0 008 | 0 003 | 0 021 | 0 048 | 0 074 | 0 059 | 0 032 | 0 019 | 0 011 |
| 25 | 0 610 | -0 017 | -0 014 | -0 009 | 0 001 | 0 014 | 0 032 | 0 055 | 0 075 | 0 068 | 0 040 | 0 025 | 0 016 | 0 010 |
| 26 | 0 640 | -0 005 | 0 003 | 0 014 | 0 029 | 0 047 | 0 064 | 0 075 | 0 069 | 0 046 | 0 030 | 0 021 | 0 015 | 0 009 |
| 27 | 0 670 | 0 017 | 0 031 | 0 046 | 0 059 | 0 068 | 0 070 | 0 063 | 0 046 | 0 034 | 0 025 | 0 019 | 0 013 | 0 008 |
| 28 | 0 700 | 0 040 | 0 053 | 0 060 | 0 063 | 0 060 | 0 053 | 0 044 | 0 036 | 0 029 | 0 022 | 0 017 | 0 012 | 0 008 |
| 29 | 0 730 | 0 052 | 0 054 | 0 052 | 0 049 | 0 045 | 0 041 | 0 036 | 0 030 | 0 025 | 0 020 | 0 016 | 0 012 | 0 007 |
| 30 | 0 760 | 0 048 | 0 045 | 0 042 | 0 040 | 0 037 | 0 034 | 0 031 | 0 027 | 0 022 | 0 018 | 0 015 | 0 011 | 0 007 |
| 31 | 0 790 | 0 040 | 0 038 | 0 036 | 0 035 | 0 032 | 0 030 | 0 027 | 0 024 | 0 021 | 0 017 | 0 014 | 0 010 | 0 007 |
| 32 | 0 820 | 0 034 | 0 033 | 0 032 | 0 031 | 0 029 | 0 027 | 0 025 | 0 022 | 0 019 | 0 016 | 0 013 | 0 010 | 0 007 |
| 33 | 0 850 | 0 029 | 0 029 | 0 028 | 0 027 | 0 026 | 0 024 | 0 022 | 0 020 | 0 018 | 0 015 | 0 012 | 0 010 | 0 006 |
| 34 | 0 879 | 0 025 | 0 025 | 0 025 | 0 024 | 0 023 | 0 022 | 0 020 | 0 018 | 0 016 | 0 014 | 0 011 | 0 009 | 0 006 |
| 35 | 0 907 | 0 022 | 0 022 | 0 022 | 0 022 | 0 021 | 0 020 | 0 018 | 0 016 | 0 014 | 0 012 | 0 010 | 0 008 | 0 005 |
| 36 | 0 933 | 0 019 | 0 020 | 0 020 | 0 019 | 0 019 | 0 018 | 0 016 | 0 015 | 0 013 | 0 011 | 0 009 | 0 007 | 0 005 |
| 37 | 0 957 | 0 017 | 0 018 | 0 018 | 0 018 | 0 017 | 0 016 | 0 015 | 0 014 | 0 012 | 0 010 | 0 008 | 0 007 | 0 005 |
| 38 | 0 979 | 0 015 | 0 016 | 0 016 | 0 015 | 0 015 | 0 014 | 0 013 | 0 012 | 0 011 | 0 009 | 0 007 | 0 006 | 0 004 |
| 39 | 1 000 | 0 011 | 0 013 | 0 013 | 0 013 | 0 012 | 0 012 | 0 011 | 0 010 | 0 009 | 0 007 | 0 006 | 0 005 | 0 004 |

FOURIER COEFFICIENTS FOR UPPER SURFACE PRESSURES  A2 TERM

CYCLE =  3

| INDEX | XI | SPAN STATIONS/ETA 1/ -0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 005 | -0 011 | -0 002 | -0 002 | -0 002 | -0 002 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 000 |
| 2 | 0 015 | -0 009 | -0 002 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 |
| 3 | 0 025 | -0 007 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 |
| 4 | 0 037 | -0 004 | -0 001 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 |
| 5 | 0 049 | -0 002 | -0 001 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 |
| 6 | 0 065 | -0 002 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 |
| 7 | 0 084 | -0 001 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 000 |
| 8 | 0 107 | -0 001 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 | 0 001 | -0 001 |
| 9 | 0 132 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 002 | 0 002 | 0 001 | -0 001 |
| 10 | 0 161 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 002 | 0 000 | -0 003 |
| 11 | 0 190 | 0 000 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 002 | -0 001 | -0 004 |
| 12 | 0 220 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 002 | 0 003 | 0 003 | 0 003 | 0 003 | 0 001 | -0 003 | -0 006 |
| 13 | 0 250 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 003 | 0 003 | 0 004 | 0 004 | 0 003 | 0 000 | -0 005 | -0 008 |
| 14 | 0 280 | 0 001 | 0 001 | 0 002 | 0 002 | 0 003 | 0 003 | 0 004 | 0 004 | 0 004 | 0 002 | -0 003 | -0 008 | -0 009 |
| 15 | 0 310 | 0 001 | 0 002 | 0 002 | 0 003 | 0 003 | 0 004 | 0 005 | 0 005 | 0 004 | 0 000 | -0 007 | -0 012 | -0 009 |
| 16 | 0 340 | 0 002 | 0 002 | 0 003 | 0 003 | 0 004 | 0 005 | 0 005 | 0 005 | 0 002 | -0 004 | -0 012 | -0 015 | -0 006 |
| 17 | 0 370 | 0 002 | 0 002 | 0 003 | 0 004 | 0 005 | 0 006 | 0 006 | 0 004 | -0 001 | -0 010 | -0 018 | -0 013 | 0 000 |
| 18 | 0 400 | 0 003 | 0 003 | 0 004 | 0 005 | 0 006 | 0 006 | 0 005 | 0 001 | -0 007 | -0 018 | -0 021 | -0 005 | 0 005 |
| 19 | 0 430 | 0 003 | 0 004 | 0 005 | 0 006 | 0 007 | 0 006 | 0 002 | -0 005 | -0 017 | -0 026 | -0 015 | 0 006 | 0 008 |
| 20 | 0 460 | 0 004 | 0 005 | 0 006 | 0 007 | 0 006 | 0 002 | -0 005 | -0 016 | -0 027 | -0 025 | 0 002 | 0 013 | 0 008 |
| 21 | 0 490 | 0 005 | 0 006 | 0 006 | 0 005 | 0 001 | -0 006 | -0 016 | -0 027 | -0 030 | -0 008 | 0 019 | 0 012 | 0 006 |
| 22 | 0 520 | 0 005 | 0 005 | 0 003 | -0 001 | -0 008 | -0 017 | -0 027 | -0 031 | -0 016 | 0 019 | 0 019 | 0 008 | 0 005 |
| 23 | 0 550 | 0 003 | 0 001 | -0 004 | -0 011 | -0 020 | -0 027 | -0 029 | -0 017 | 0 015 | 0 029 | 0 011 | 0 005 | 0 003 |
| 24 | 0 580 | -0 003 | -0 008 | -0 015 | -0 022 | -0 026 | -0 024 | -0 012 | 0 015 | 0 034 | 0 015 | 0 006 | 0 003 | 0 002 |
| 25 | 0 610 | -0 010 | -0 016 | -0 021 | -0 021 | -0 014 | 0 000 | 0 022 | 0 035 | 0 019 | 0 004 | 0 003 | 0 002 | 0 002 |
| 26 | 0 640 | -0 012 | -0 013 | -0 009 | 0 001 | 0 015 | 0 027 | 0 030 | 0 017 | 0 002 | 0 002 | 0 002 | 0 002 | 0 002 |
| 27 | 0 670 | -0 004 | 0 004 | 0 014 | 0 020 | 0 022 | 0 018 | 0 009 | 0 000 | 0 001 | 0 002 | 0 002 | 0 002 | 0 001 |
| 28 | 0 700 | 0 005 | 0 012 | 0 012 | 0 010 | 0 005 | 0 000 | -0 001 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 |
| 29 | 0 730 | 0 006 | 0 003 | 0 000 | -0 002 | -0 002 | -0 001 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 |
| 30 | 0 760 | 0 002 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 |
| 31 | 0 790 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 |
| 32 | 0 820 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 |
| 33 | 0 850 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 34 | 0 879 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 35 | 0 907 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 36 | 0 933 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 37 | 0 957 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 38 | 0 979 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 | 0 000 |
| 39 | 1 000 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 |

FOURIER COEFFICIENTS FOR UPPER SURFACE PRESSURES  B1 TERM

CYCLE =  3

| INDEX | XI | SPAN STATIONS/ETA 1/ -0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 005 | 0 041 | 0 037 | 0 047 | 0 054 | 0 059 | 0 063 | 0 066 | 0 070 | 0 073 | 0 077 | 0 080 | 0 082 | 0 079 |
| 2 | 0 015 | 0 066 | 0 033 | 0 041 | 0 047 | 0 051 | 0 055 | 0 059 | 0 063 | 0 067 | 0 071 | 0 074 | 0 077 | 0 073 |
| 3 | 0 025 | 0 072 | 0 030 | 0 035 | 0 041 | 0 045 | 0 049 | 0 053 | 0 056 | 0 061 | 0 065 | 0 069 | 0 072 | 0 067 |
| 4 | 0 037 | 0 058 | 0 027 | 0 032 | 0 036 | 0 040 | 0 044 | 0 047 | 0 051 | 0 055 | 0 060 | 0 064 | 0 067 | 0 061 |
| 5 | 0 049 | 0 044 | 0 025 | 0 029 | 0 033 | 0 036 | 0 040 | 0 043 | 0 047 | 0 051 | 0 055 | 0 059 | 0 062 | 0 055 |
| 6 | 0 065 | 0 035 | 0 023 | 0 027 | 0 030 | 0 033 | 0 036 | 0 040 | 0 043 | 0 047 | 0 051 | 0 055 | 0 059 | 0 050 |
| 7 | 0 084 | 0 030 | 0 022 | 0 025 | 0 028 | 0 031 | 0 034 | 0 037 | 0 040 | 0 044 | 0 048 | 0 052 | 0 056 | 0 043 |
| 8 | 0 107 | 0 027 | 0 021 | 0 023 | 0 026 | 0 029 | 0 031 | 0 034 | 0 038 | 0 042 | 0 046 | 0 051 | 0 051 | 0 037 |
| 9 | 0 132 | 0 024 | 0 021 | 0 022 | 0 025 | 0 027 | 0 030 | 0 033 | 0 036 | 0 040 | 0 045 | 0 048 | 0 046 | 0 034 |
| 10 | 0 161 | 0 023 | 0 020 | 0 021 | 0 023 | 0 026 | 0 028 | 0 031 | 0 035 | 0 038 | 0 042 | 0 044 | 0 043 | 0 032 |
| 11 | 0 190 | 0 022 | 0 020 | 0 021 | 0 022 | 0 024 | 0 027 | 0 030 | 0 033 | 0 037 | 0 040 | 0 043 | 0 042 | 0 032 |
| 12 | 0 220 | 0 021 | 0 019 | 0 020 | 0 022 | 0 024 | 0 026 | 0 029 | 0 032 | 0 035 | 0 039 | 0 042 | 0 042 | 0 032 |
| 13 | 0 250 | 0 020 | 0 019 | 0 020 | 0 021 | 0 023 | 0 025 | 0 028 | 0 031 | 0 035 | 0 039 | 0 043 | 0 044 | 0 034 |
| 14 | 0 280 | 0 020 | 0 019 | 0 019 | 0 021 | 0 022 | 0 024 | 0 027 | 0 031 | 0 035 | 0 040 | 0 046 | 0 047 | 0 036 |
| 15 | 0 310 | 0 020 | 0 019 | 0 019 | 0 020 | 0 022 | 0 024 | 0 028 | 0 032 | 0 037 | 0 043 | 0 050 | 0 052 | 0 038 |
| 16 | 0 340 | 0 019 | 0 019 | 0 019 | 0 020 | 0 022 | 0 025 | 0 029 | 0 033 | 0 039 | 0 047 | 0 057 | 0 057 | 0 037 |
| 17 | 0 370 | 0 019 | 0 019 | 0 019 | 0 021 | 0 023 | 0 026 | 0 030 | 0 036 | 0 044 | 0 055 | 0 066 | 0 060 | 0 032 |
| 18 | 0 400 | 0 019 | 0 019 | 0 020 | 0 021 | 0 024 | 0 028 | 0 034 | 0 041 | 0 051 | 0 066 | 0 076 | 0 057 | 0 023 |
| 19 | 0 430 | 0 019 | 0 020 | 0 021 | 0 023 | 0 027 | 0 032 | 0 039 | 0 048 | 0 062 | 0 080 | 0 081 | 0 044 | 0 012 |
| 20 | 0 460 | 0 020 | 0 021 | 0 023 | 0 026 | 0 032 | 0 038 | 0 047 | 0 060 | 0 077 | 0 092 | 0 073 | 0 025 | 0 004 |
| 21 | 0 490 | 0 022 | 0 024 | 0 027 | 0 032 | 0 039 | 0 048 | 0 059 | 0 074 | 0 092 | 0 096 | 0 049 | 0 006 | -0 001 |
| 22 | 0 520 | 0 025 | 0 029 | 0 034 | 0 041 | 0 050 | 0 061 | 0 075 | 0 091 | 0 103 | 0 080 | 0 015 | -0 005 | -0 003 |
| 23 | 0 550 | 0 032 | 0 037 | 0 045 | 0 054 | 0 065 | 0 078 | 0 091 | 0 104 | 0 098 | 0 039 | -0 008 | -0 007 | -0 003 |
| 24 | 0 580 | 0 042 | 0 050 | 0 060 | 0 071 | 0 082 | 0 094 | 0 104 | 0 103 | 0 062 | -0 005 | -0 013 | -0 006 | -0 002 |
| 25 | 0 610 | 0 056 | 0 066 | 0 077 | 0 088 | 0 097 | 0 103 | 0 098 | 0 066 | 0 005 | -0 020 | -0 010 | -0 003 | -0 001 |
| 26 | 0 640 | 0 072 | 0 082 | 0 091 | 0 096 | 0 094 | 0 082 | 0 052 | 0 006 | -0 022 | -0 014 | -0 006 | -0 002 | 0 000 |
| 27 | 0 670 | 0 080 | 0 085 | 0 082 | 0 072 | 0 053 | 0 028 | -0 001 | -0 020 | -0 015 | -0 008 | -0 003 | -0 001 | 0 000 |
| 28 | 0 700 | 0 066 | 0 056 | 0 042 | 0 025 | 0 008 | -0 007 | -0 013 | -0 012 | -0 008 | -0 004 | -0 002 | 0 000 | 0 000 |
| 29 | 0 730 | 0 037 | 0 022 | 0 010 | 0 003 | -0 002 | -0 005 | -0 007 | -0 006 | -0 005 | -0 003 | -0 001 | 0 000 | 0 000 |
| 30 | 0 760 | 0 014 | 0 008 | 0 005 | 0 002 | 0 000 | -0 002 | -0 003 | -0 004 | -0 003 | -0 002 | -0 001 | 0 000 | 0 001 |
| 31 | 0 790 | 0 005 | 0 005 | 0 003 | 0 002 | 0 000 | -0 001 | -0 002 | -0 002 | -0 002 | -0 001 | 0 000 | 0 000 | 0 001 |
| 32 | 0 820 | 0 003 | 0 003 | 0 002 | 0 001 | 0 000 | 0 000 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 001 |
| 33 | 0 850 | 0 002 | 0 002 | 0 002 | 0 001 | 0 000 | 0 000 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 | 0 000 |
| 34 | 0 879 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | 0 000 | -0 001 | -0 001 | -0 001 | -0 001 | 0 000 | 0 000 |
| 35 | 0 907 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | -0 001 | -0 001 | 0 000 |
| 36 | 0 933 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | -0 001 | -0 001 | -0 001 |
| 37 | 0 957 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | -0 001 | -0 002 | -0 003 |
| 38 | 0 979 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | 0 000 | 0 000 | -0 001 | -0 002 | -0 005 |
| 39 | 1 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | -0 001 | -0 003 | -0 009 |

FOURIER COEFFICIENTS FOR UPPER SURFACE PRESSURES  B2 TERM

CYCLE =  3

| INDEX | XI | SPAN STATIONS/ETA 1/ −0 10 | 2/ 0 00 | 3/ 0 10 | 4/ 0 19 | 5/ 0 29 | 6/ 0 39 | 7/ 0 49 | 8/ 0 58 | 9/ 0 68 | 10/ 0 77 | 11/ 0 84 | 12/ 0 90 | 13/ 0 95 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 005 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 002 | 0 002 | 0 001 | 0 001 | 0 000 |
| 2 | 0 015 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 |
| 3 | 0 025 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 |
| 4 | 0 037 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 |
| 5 | 0 049 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | 0 000 | −0 001 |
| 6 | 0 065 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 002 |
| 7 | 0 084 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 003 |
| 8 | 0 107 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 003 | −0 003 |
| 9 | 0 132 | 0 000 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 002 | −0 004 | −0 003 |
| 10 | 0 161 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | −0 001 | −0 002 | −0 003 | −0 003 | −0 003 |
| 11 | 0 190 | 0 000 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 003 | −0 004 | −0 004 | −0 003 |
| 12 | 0 220 | 0 000 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 002 | −0 003 | −0 005 | −0 005 | −0 002 |
| 13 | 0 250 | 0 001 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 003 | −0 005 | −0 006 | −0 005 | 0 000 |
| 14 | 0 280 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 002 | −0 004 | −0 007 | −0 008 | −0 005 | 0 002 |
| 15 | 0 310 | 0 001 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 002 | −0 004 | −0 006 | −0 009 | −0 008 | −0 002 | 0 007 |
| 16 | 0 340 | 0 001 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 003 | −0 006 | −0 009 | −0 011 | −0 007 | 0 004 | 0 011 |
| 17 | 0 370 | 0 001 | 0 001 | 0 000 | 0 000 | −0 001 | −0 003 | −0 005 | −0 009 | −0 012 | −0 012 | −0 002 | 0 012 | 0 013 |
| 18 | 0 400 | 0 001 | 0 000 | 0 000 | −0 001 | −0 002 | −0 005 | −0 009 | −0 013 | −0 014 | −0 009 | 0 009 | 0 019 | 0 011 |
| 19 | 0 430 | 0 000 | 0 000 | −0 001 | −0 003 | −0 005 | −0 009 | −0 013 | −0 016 | −0 013 | 0 002 | 0 022 | 0 019 | 0 007 |
| 20 | 0 460 | −0 001 | −0 001 | −0 003 | −0 006 | −0 010 | −0 014 | −0 016 | −0 015 | −0 004 | 0 019 | 0 028 | 0 011 | 0 003 |
| 21 | 0 490 | −0 002 | −0 004 | −0 007 | −0 010 | −0 014 | −0 017 | −0 015 | −0 006 | 0 014 | 0 034 | 0 019 | 0 003 | 0 000 |
| 22 | 0 520 | −0 005 | −0 007 | −0 011 | −0 015 | −0 016 | −0 014 | −0 005 | 0 012 | 0 034 | 0 031 | 0 004 | −0 001 | −0 001 |
| 23 | 0 550 | −0 008 | −0 011 | −0 014 | −0 014 | −0 011 | −0 001 | 0 014 | 0 033 | 0 037 | 0 008 | −0 003 | −0 002 | −0 001 |
| 24 | 0 580 | −0 010 | −0 012 | −0 010 | −0 005 | 0 006 | 0 020 | 0 034 | 0 037 | 0 012 | −0 006 | −0 003 | −0 002 | −0 001 |
| 25 | 0 610 | −0 007 | −0 004 | 0 004 | 0 014 | 0 025 | 0 033 | 0 030 | 0 009 | −0 008 | −0 005 | −0 003 | −0 002 | −0 001 |
| 26 | 0 640 | 0 003 | 0 011 | 0 020 | 0 025 | 0 024 | 0 016 | 0 001 | −0 009 | −0 006 | −0 004 | −0 002 | −0 002 | −0 001 |
| 27 | 0 670 | 0 010 | 0 015 | 0 014 | 0 009 | 0 001 | −0 006 | −0 010 | −0 005 | −0 003 | −0 003 | −0 002 | −0 001 | −0 001 |
| 28 | 0 700 | 0 009 | 0 003 | −0 002 | −0 006 | −0 007 | −0 005 | −0 003 | −0 003 | −0 003 | −0 002 | −0 002 | −0 001 | −0 001 |
| 29 | 0 730 | 0 002 | −0 003 | −0 004 | −0 003 | −0 002 | −0 002 | −0 002 | −0 002 | −0 002 | −0 002 | −0 001 | −0 001 | −0 001 |
| 30 | 0 760 | −0 002 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | 0 000 |
| 31 | 0 790 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | 0 000 |
| 32 | 0 820 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | 0 000 |
| 33 | 0 850 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 001 | −0 001 | −0 001 | −0 001 | 0 000 | 0 000 |
| 34 | 0 879 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | −0 001 | −0 001 | −0 001 | 0 000 | 0 000 | 0 000 |
| 35 | 0 907 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 36 | 0 933 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 37 | 0 957 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 38 | 0 979 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |
| 39 | 1 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 | 0 000 |

**********
**********
*** Note  ATRAN3S prints similar output for lower surface pressures  ****
***  and pressure differences  The corresponding results for  ****
***  magnituides and phase angles are also computed and printed ****
**********
**********

MAGNITUDES AND PHASE ANGLES FOR LIFT AND MOMENT COEFFICIENTS

CYCLE = 3

| | | SPAN STATIONS/ETA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | XI | 1/ | 2/ | 3/ | 4/ | 5/ | 6/ | 7/ | 8/ | 9/ | 10/ | 11/ | 12/ | 13/ |
| INDEX | | -0 10 | 0 00 | 0 10 | 0 19 | 0 29 | 0 39 | 0 49 | 0 58 | 0 68 | 0 77 | 0 84 | 0 90 | 0 95 |

MAGNITUDE OF LIFT COEFFICIENTS

0 00000 0 05040 0 04924 0 04786 0 04597 0 04353 0 04050 0 03679 0 03237 0 02732 0 02187 0 01616 0 00971

PHASE ANGLE OF LIFT COEFFICIENTS

0 00 170 08 169 99 170 45 171 07 171 76 172 45 173 10 173 64 173 99 174 02 173 44 171 22

MAGNITUDE OF MOMENT COEFFICIENTS

0 00000 0 00963 0 00908 0 00850 0 00782 0 00706 0 00624 0 00538 0 00449 0 00361 0 00278 0 00200 0.00116

PHASE ANGLE OF MOMENT COEFFICIENTS

0 00 254 57 250 25 245 86 241 59 237 26 232 70 227 79 222 53 217 24 212 34 208 16 204 54

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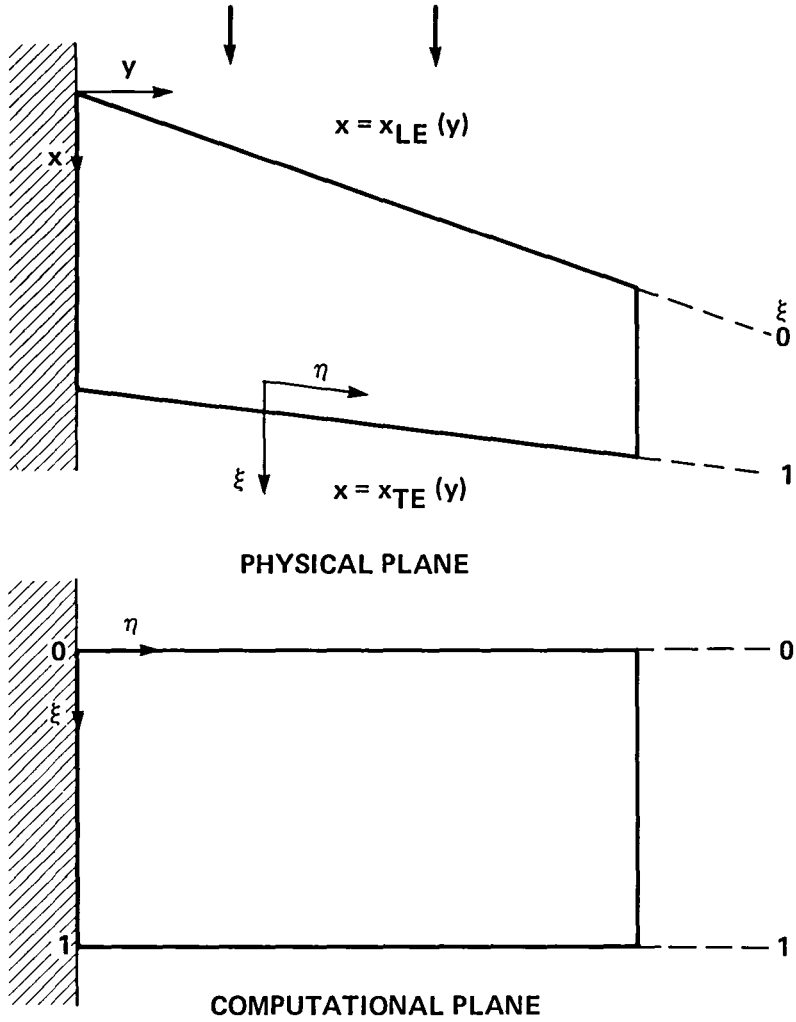


Figure 1.- Wing planform transformation.

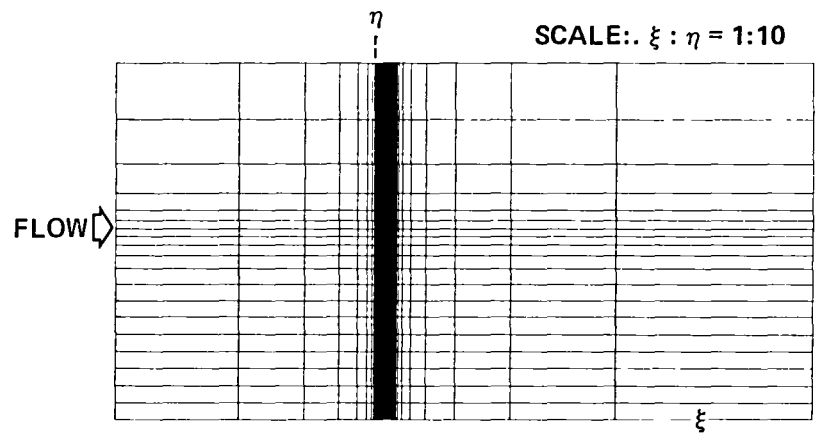


Figure 2.- Computational mesh (64 × 20): $\xi$-$\eta$ plane.

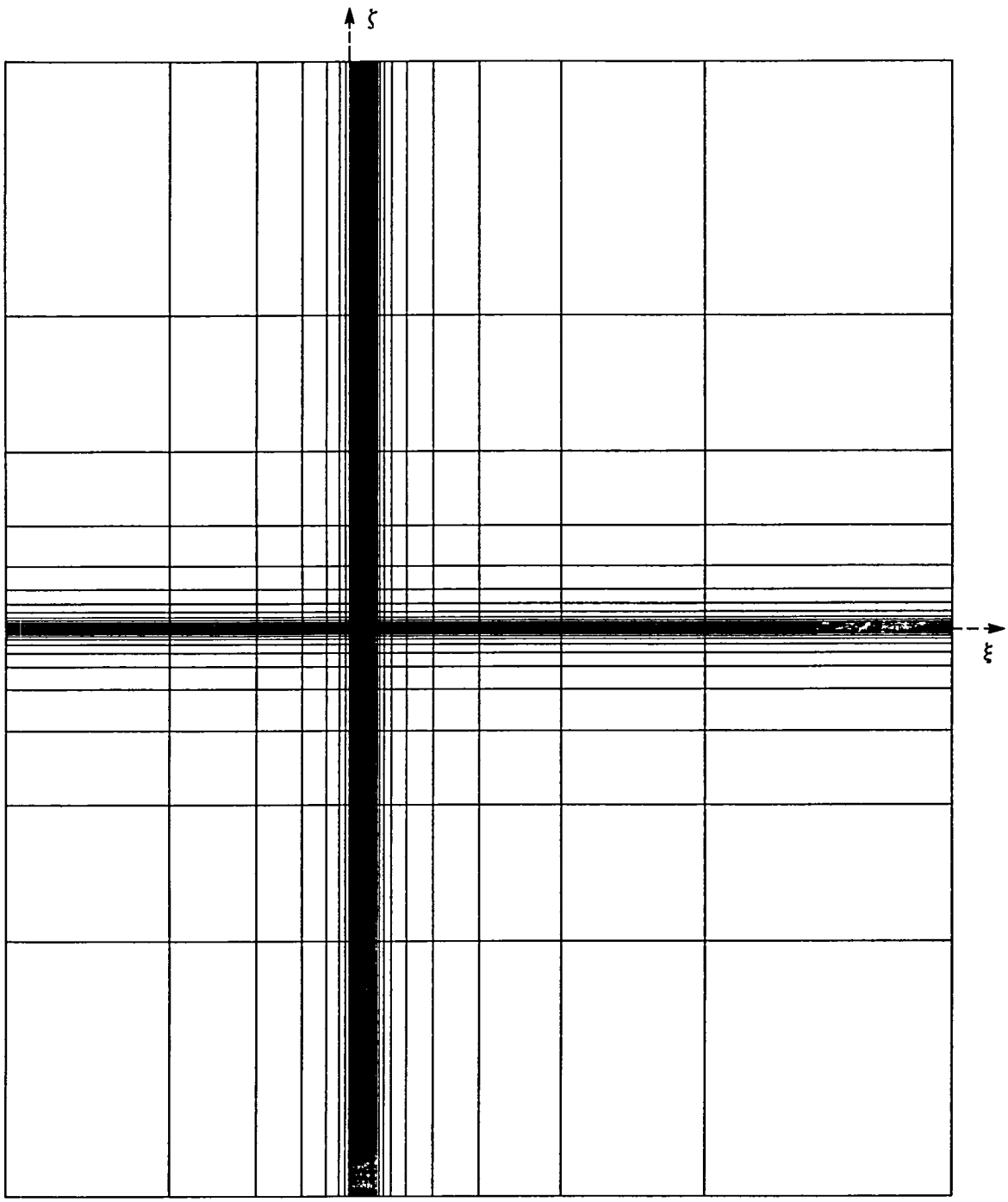


Figure 3.- Computational mesh (64 × 40): $\xi$-$\eta$ plane.

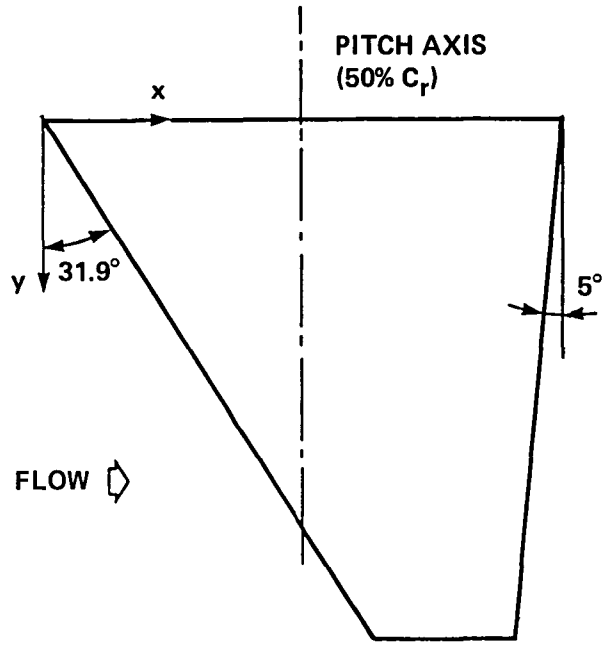


Figure 4.- Planform of the F-5 wing: aspect ratio = 2.98, taper ratio = 0.31, leading-edge sweep = 32°.

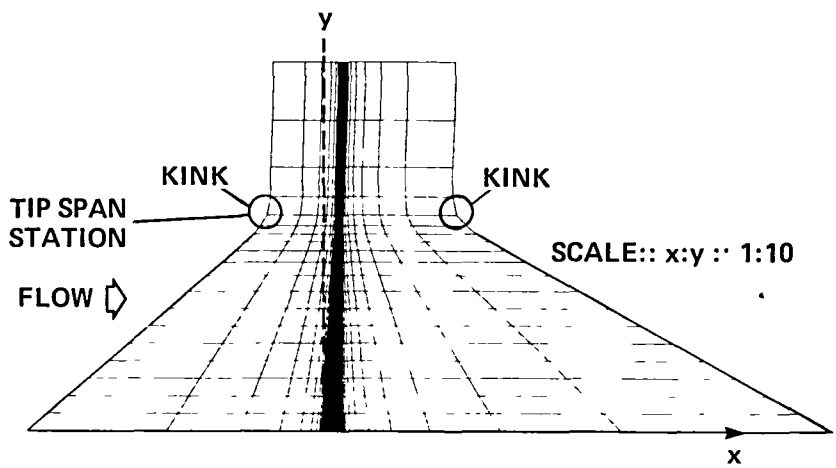


Figure 5.- Physical mesh (64 × 20) in x-y plane: conventional shearing transformation.

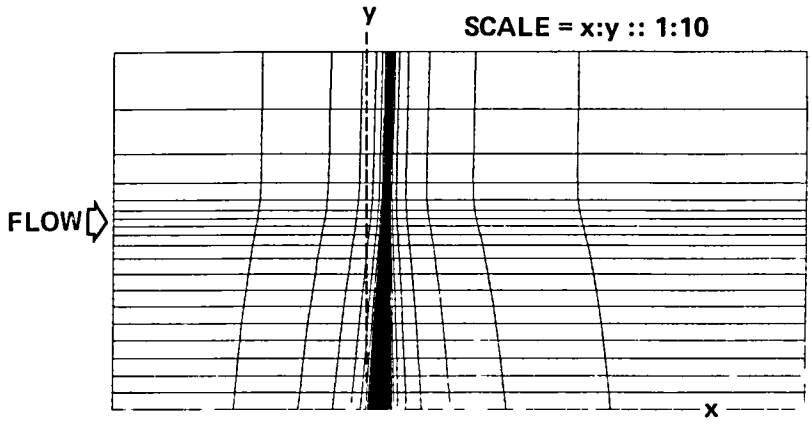


Figure 6.- Physical mesh (64 v 20) in x-y plane: modified shearing transformation.

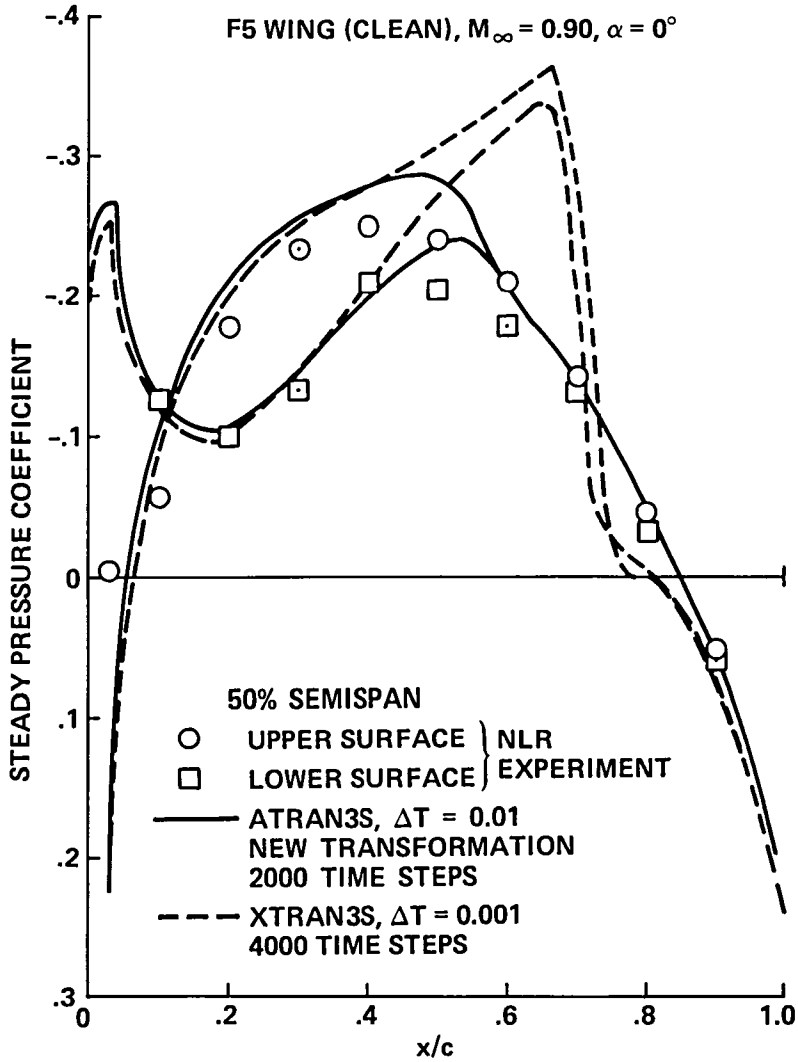


Figure 7.- Effect of transformation on steady pressures: clean F-5 wing, $M_\infty$ = 0.90, $\alpha$ = 0°.

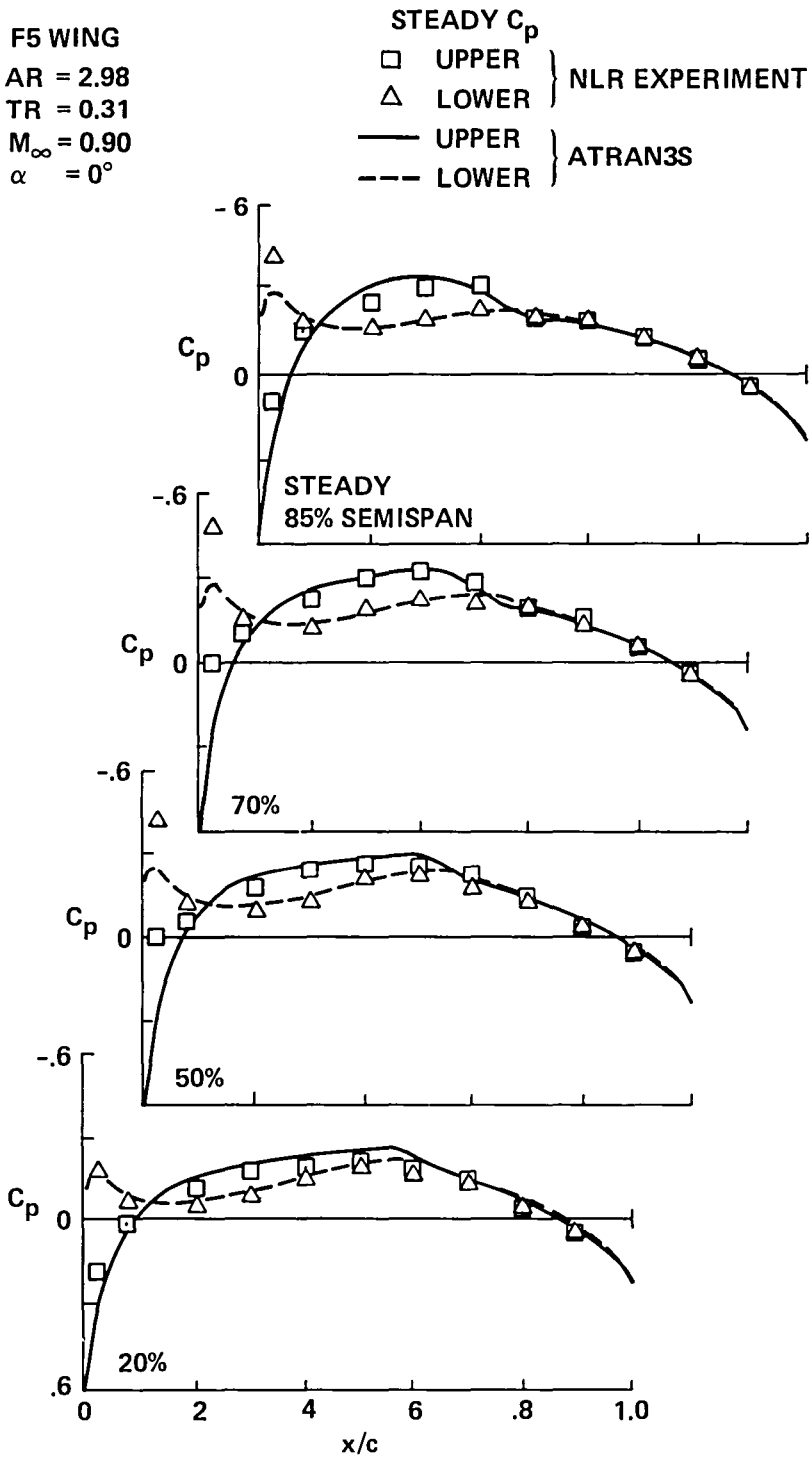


Figure 8.- Comparison of steady pressures between theory and experiment for F-5 wing: aspect ratio = 2.98, taper ratio = 0.31, $M_\infty$ = 0.90, α = 0°.

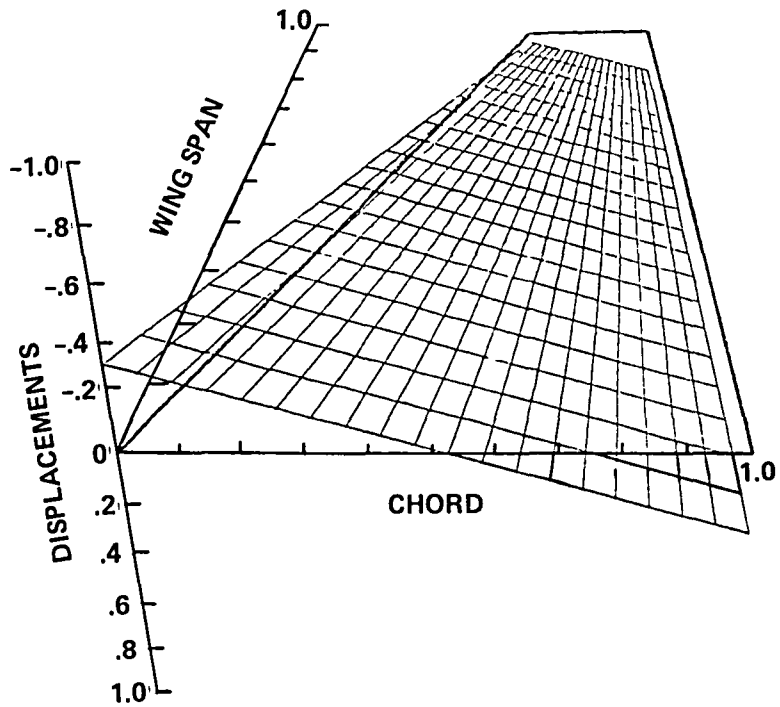


Figure 9.- Unsteady modal motion of the F-5 wing.

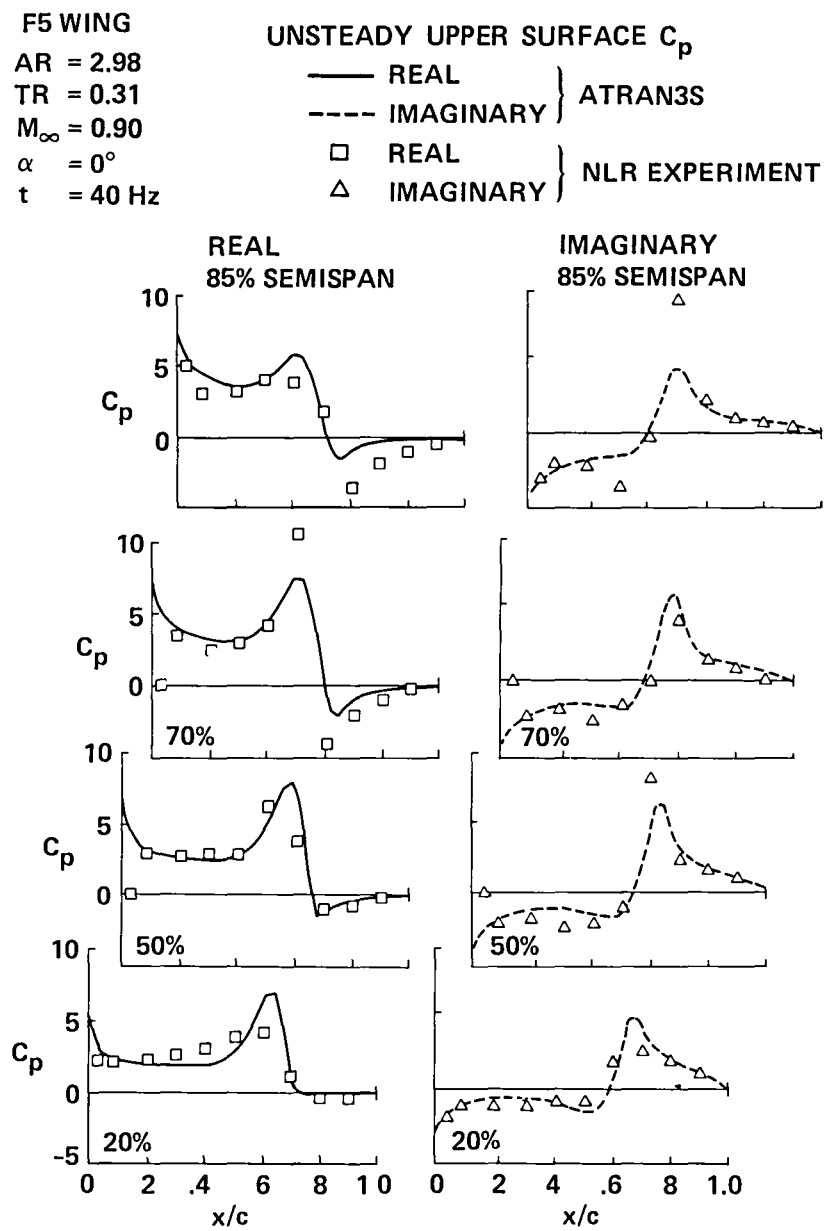


Figure 10.- Comparison of unsteady upper-surface pressures on F-5 wing from theory and experiment: aspect ratio = 2.98, taper ratio = 0.31, $M_\infty$ = 0.90, α = 0°, t = 40 Hz.

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15 Supplementary Notes

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16 Abstract

This report explains the development and applications of the unsteady transonic code ATRAN3S for clean wings. Explanations of the unsteady, transonic small-disturbance aerodynamic equations that are used and their solution procedures are discussed. A detailed user's guide, along with input and output for a sample case, is given.

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